656.06
INT

VOL. XXIV. — No. 1. JANUARY 1947

Monthly Bulletin of the International Railway Congress Association

(English Edition)

6-5606 HOT
International Railway Congress Assoc. Bulletin

ANALYTICAL TABLE OF ARTICLES

ARRANGED ACCORDING TO THE DECIMAL CLASSIFICATION

(1947)

LUTHER MAY 4 '49

	Month.	Pages.
3. Sociology in General.		
31. Statistics.		
313. Statistics on special topics.		
313 .385. Railway statistics in general.		
L.N.E.R. Statistics. — Railways, Roads, Canals *(New book)*	September.	882
38. Commerce. Communications.		
385. Railways from a general, economic and financial point of view.		
385. (02. Railway handbooks, treatises, etc.		
The Railway Handbook, 1946-1947 *(New book)*	»	880
385. (06. Societies, associations, scientific congresses.		
385. (06.111. International Railway Congress Association. Official documents.		
Official information issued by the Permanent Commission of the International Railway Congress Association : Meeting held by the Permanent Commission in Brussels, on the 15th February 1947. *Appendix :* List of Members of the Permanent Commission (15th February 1947)	March.	472
Final summaries adopted at the XIVth Session of the International Railway Congress Association (Lucerne, June 1947)	June.	647
385. (06.112. International Railway Congress Association. Proceedings.		
Summary of the Proceedings at the XIVth Session (Lucerne, 1947) of the International Railway Congress Association	August.	718
Fourteenth Session, Lucerne, 23-28 June 1947. General Proceedings in Section and in Plenary Meetings. 1st Section. — Way and Works : Inaugural meeting	November.	939
2nd and 5th Sections meeting jointly : 2nd Section. — Locomotives and Rolling Stock. 5th Section. — Light Railways and Colonial Railways. Inaugural meeting	»	954

	Month.	Pages.
385. (06.119. Miscellaneous.		
The International Railway Congress Association and the Centenary of the Swiss Railways	March.	471
385. (09. History, description of railways, etc.		
The history of the centenarian Hungarian Railways, by Ladilaus VARGA	April.	527
The Swiss Federal Railways during the war, by G. DREYER	May. June.	555 591
The centenary of the Danish State Railways	September.	875
The London Midland & Scottish Railway Company. — A record of large scale organisation and management, 1923-1946 *(New book)*	October.	934
De IJzeren Weg. — Holland bouwt op. (The Railway. — Reconstruction in Netherlands.) *(New book)*	»	937
The Swedish State Railways, by Arne SJÖBERG	December.	1037
385. (092. Biographies. Obituary notices.		
John J. PELLEY	February.	274
385. (093. History.		
The International Railway Congress Association and the Centenary of the Swiss Railways	March.	471
385 .3. State control over railways.		
Railway inspection *(New book)*	September.	879
385 .5. Staff.		
385 .51. Relations between staff and management of railways.		
385 .517. Institutions founded by the management of railways for the benefit of the staff.		
385 .517.7. Tenement houses.		
The interest the Railway Companies would have in building houses for their staff of all ranks, or in assisting the building of such houses (Question IV, 14th Congress).		
Report (Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey and Jugoslavia) by E. L. ANTONUCCI	March.	277
Supplement to report, by A. P. J. BALL	»	353
Special Report, by F. PINTO TEIXEIRA	April.	506
Supplement to report, by E. L. ANTONUCCI	May.	529

656.06
INT
v.24
cop. 2

	Month.	Pages.
621. Mechanical and electrical engineering.		
621 .1. Steam engineering.		
621 .13. Locomotive engines.		
621 .13(09. Historic.		
The locomotives of Sir Nigel Gresley, by O. S. NOCK *(New book)*	July.	714
621 .131. Theory of the locomotive.		
621 .131.1. Tractive power. Power developed.		
The development of locomotive power at speed	November.	992
621 .132. Various types of locomotives.		
621 .132.3. Passenger train locomotives with 4 or more coupled wheels.		
4-8-2 class « 15 F » locomotives for the South African Railways *(New book)*	September.	877
Norfolk & Western steam switcher has automatic controls	October.	911
The « Liberation » locomotive — 2-8-0 type with double bogie tender for European use *(New book)*	»	933
2-8-4 locomotive of the Roumanian State Railways, by A. ZANESCO	December.	1021
621 .132.5. Goods locomotives with more than 6 coupled wheels.		
4-8-2 class « 15 F » locomotives for the South African Railways *(New book)*	September.	877
The « Liberation » locomotive — 2-8-0 type with double bogie tender for European use *(New book)*	October.	933
621 .132.8. Special types. Steam railcars, etc.		
Norfolk & Western steam switcher has automatic controls	»	911
621 .133. Production of steam in locomotives.		
621 .133.1. Combustion. Fuel. Petroleum. Fuel consumption of locomotives.		
The oil firing of steam locomotives. A survey of the present position in certain European and Overseas countries, by F. STRAUSS	July.	837
Conversion from coal to oil burning	November.	997
621 .133.3. Boiler. Plates. Tubes.		
Research into the causes of locomotive boiler explosions, by M. CHAM	May.	583
621 .138. Laying up and maintaining the locomotives.		
Lighting « Trolley » for enginehouses	June.	629

	Month.	Pages.
621 .3. Electrical engineering.		
621 .32 Electric lighting.		
Lighting « Trolley » for enginehouses	June.	629
621 .33. Electric railways and tramways. Railway electrification.		
Individual axle drive. Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds *(to be continued)*, by Adolphe-M. HUG	September.	823
Chapter III	October.	885
Chapter IV	December.	999
621 .4. Air, gas and oil engines.		
621 .43. Ignited-gas engines. Internal combustion engines.		
621 .431. General.		
621 .431.7. Various applications.		
621 .431.72. Railway traction.		
Light railcars for colonial railways, by J. L. KOFFMAN	July.	655
621 .438. Gas-turbine engines.		
Gas turbines for railway traction	January.	143
Gas turbines for traction purposes. A summary of German developments	May.	586
623. Military and naval engineering.		
Longmoor Military Railway. — Transportation Training Centre of the Corps of Royal Engineers *(New book)*	September.	882
624. Bridges and roofs.		
624 .6. Arched bridges.		
624 .63. Concrete arched bridges.		
Luzancy bridge, France	October.	918
624 .7. Composite structures.		
The welded bridge over the river Birs, near Bärschwil, Swiss Federal Railways, by F. BÜHLER	»	919
625. Railway and road engineering.		
625 .1. Railway engineering. Way and works.		
625 .14. Permanent way.		
La réalisation d'une voie ferrée de qualité. Les résultats techniques, économiques et sociaux de quinze années d'organisation. (The creation of a high-class railway track. Technical, economic and social results of fifteen years of organisation) by R. CAMPUS *(New book)*	February.	272
Asphalt ballast, welded rails, good drainage solve this station-track problem, by John R. SCOFIELD	October.	904

	Month.	Pages.
625 .142. Supports.		
Sleepers : *a*) different types; *b*) maintenance methods; *c*) financial comparison (Question I, 14th Congress).		
Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by J. C. L. TRAIN	January.	49
Report (Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey and Jugoslavia), by O. LEDUC	March.	361
Special Report, by J. VAN RIJN	April.	481
General Proceedings in Section and in Plenary Meeting	November.	941
625 .143. Rails and their fastenings.		
A. R. E. A. adopts 3 new rail designs	June.	631
625 .143.3. Wear and breaking of rails.		
Testing with Magnaflux on the D. & R. G. W., by RAY McBRIAN	November.	986
625 .143.4. Rail joints.		
Nine years of strip welding on the New Haven, by A. L. BARTLETT	December.	1051
625 .144. Platelaying.		
625 .144.4. Platelaying. Staking out, ballasting, etc.		
Big special track-work job goes in smoothly, by T. H. BEEBE	June.	610
This new ballast cleaner is different	»	619
Testing with Magnaflux on the D. & R. G. W., by RAY McBRIAN	November.	986
625 .2. Railway rolling stock.		
Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : *a*) choice of the method of construction; *b*) use of special steels; *c*) use of alloys (Question II, 14th Congress).		
Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by Eyre A. W. TURBETT	January.	1
Report (Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey and Jugoslavia), by R. GUIGNARD	February.	153
Report (Light Railways and Colonial Railways of all countries), by W. A. VRIELYNCK	»	245
Special Report, by J. de AGUINAGA	April.	487
General Proceedings in Section and in Plenary Meeting	November.	956
625 .21. Principal parts of the vehicles.		
625 .212. Axles. Wheels. Tyres. Balancing of the wheels.		
Safe stresses in axles. Determination of axle shape and dimensions, by M. KAMMERER	July.	674

	Month.	Pages.
625 .23. Passenger coaches.		
Weight reductions in passenger cars	February.	265
625 .6. Light railways. Tramways.		
625 .61. Light railway engineering.		
625 .616. Locomotives.		
Light railcars for colonial railways, by J. L. KOFFMAN	July.	655
656. Transport by road, rail, etc.		
Les transports en Belgique depuis la libération, par le MINISTERE DES COMMUNICATIONS (Belgique). (Transport in Belgium since the liberation, by the Ministry of Communications, Belgium) *(New book)*	October.	931
656 .(02. General treatises.		
Traité d'exploitation des transports (Treatise on the organisation of transport), by P. DE GROOTE *(New book)*	July.	711
656. 2. Carriage by railway. Railway working.		
656 .21. Station working.		
656 .22. Trains.		
656 .222. Train working.		
656 .222.5. Passenger service.		
As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average and light traffic, during and outside rush hours of the day (Question III, 14th Congress).		
Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by R. J. HARVEY	January.	17
Report (Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey, Jugoslavia), by M. LORRIOT	January.	29
Special Report, by E. F. Baron VAN HAERSOLTE	April.	501
Supplement to report, by M. LORRIOT	May.	551
656 .226. Luggage and parcels service.		
Expediting miscellaneous traffic on the L. M. S. R.	September.	866
656 .23. Traffic and rates.		
656 .234. Rates and conditions for carrying passengers and luggage, dogs and miscellaneous articles. Tickets. Free passes. Reduced fares.		
Tickets, by Lionel WIENER. — *Part E* : Ticket representation of tariffs. Special tickets. *(Concluded.)*	July.	685

	Month.	Pages.
656 .25. Safety precautions. Signals.		
Railway Signalling and Communications. — Installation and maintenance *(New book)*	September.	881
Cours d'exploitation des chemins de fer. *Tome II :* Exploitation technique. Signalisation. Enclenchements. Commande centralisée. Dispatching. (Railway operating course. *Vol. II :* Equipment used in connection with traffic operation. Signalling. Interlocking. Centralised traffic control. Dispatching or Control of train movements), by U. LAMALLE *(New book)*	December.	1056
656 .251. Signals in general.		
Association of American Railroads (A. A. R.) — American Railway Signaling and Practices. *Chapter II :* Symbols, Aspects and indications *(New book)*	»	1057
656 .254. Apparatus for communicating information at long distances. Alarm bells and special warning devices. Telegraph. Telephone. Communication between stations and trains in motion. Various systems of working. Train dispatchers. Automatic train control.		
Carryphone in service on Pennsylvania, by W. R. TRIEM	June.	624
Radio in railroad tunnels	»	627
American Railway Signaling Principles and Practices. — *Chapter IV :* Centralized traffic control *(New book)*	October.	936
665 .885. Autogenous welding.		
Nine years of strip welding on the New Haven, by A. L. BARTLETT	December.	1051
669. Metallurgy and assaying.		
Weight reductions in passenger cars	February.	265
Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : *a*) choice of the method of construction; *b*) use of special steels; c) use of alloys (Question II, 14th Congress).		
Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by Eyre A. W. TURBETT	January.	1
Report (Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey and Jugoslavia), by R. GUIGNARD	February.	153
Report (Light Railways and Colonial Railways of all countries), by W. A. VRIELYNCK	»	245
Special Report, by J. de AGUINAGA	April.	487
General Proceedings in Section and in Plenary Meeting	November.	956
69. Building.		
691. Materials. Processes. Preservatives.		
Methods of improving strength, durability and wear resistance of concrete	June.	637

	Month.	Pages.
7. Fine arts.		
72. Architecture.		
725. Public buildings,		
725. 3. Transportation and storage.		
725 .31. Railway passenger stations.		
What about our railroad stations ? By J.-C. SHERRICK	October.	924
725 .32. Railway freight houses.		
Large concrete building takes a trip	July.	705

CONTENTS

OF THE

24th YEAR OF THE ENGLISH EDITION.

	Pages.	Numbers of the decimal classification.
No. 1. — JANUARY 1947.		
I. **Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : a) choice of the method of construction; b) use of special steels; c) use of alloys** (Question II, 14th Congress). Report *(America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt)*, by Eyre A. W. TURBETT	1	625 .2 & 669
II. **As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day** (Question III, 14th Congress). Report *(America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt)*, by R. J. HARVEY	17	656 .222.5
II. **As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day** (Question III, 14th Congress). Report *(Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey, Jugoslavia)*, by M. LORRIOT	29	656 .222.5
V. **Sleepers : a) different types; b) maintenance methods; c) financial comparison** (Question I, 14th Congress). Report *(America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt)*, by J. C. L. TRAIN	49	625 .142
V. **Gas turbines** for railway **traction**	143	621 .438
VI. MONTLY BIBLIOGRAPHY	1	016 .385 (02

	Pages.	Numbers of the decimal classification.
No. 2. — FEBRUARY 1947.		
I. **Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : a) choice of the method of construction; b) use of special steels; c) use of alloys** (Question II, 14th Congress). Report *(Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey* and *Jugoslavia)* by R. GUIGNARD	153	**625** .2 & **669**
II. **Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : a) choice of the method of construction; b) use of special steels; c) use of alloys** (Question II, 14th Congress). Report *(Light Railways and Colonial Railways of all countries)* by W. A. VRIELYNCK	245	**625** .2 & **669**
III. **Weight reductions** in **passenger cars**	265	**625** .23 (.73) & **669** (.7
IV. NEW BOOKS AND PUBLICATIONS : **La réalisation d'une voie ferrée de qualité.** Les résultats techniques, économiques et sociaux de quinze années d'organisation. **(The creation of a high-class railway track.** Technical, economic and social results of fifteen years of organisation) by R. CAMPUS	272	**625** .14
V. OBITUARY : John J. **PELLEY**	274	**385** (09.2
No. 3. — MARCH 1947.		
I. **The interest the Railway Companies would have in building houses for their staff of all ranks, or in assisting the building of such houses** (Question IV, 14th Congress). Report *(Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey* and *Jugoslavia)* by E. L. ANTONUCCI	277	**385** .517.7
II. **The interest the Railway Companies would have in building houses for their staff of all ranks, or in assisting the building of such houses** (Question IV, 14th Congress). Supplement to report, by A. P. J. BALL .	353	**385** .517.7
III. **Sleepers : a) different types; b) maintenance methods; c) financial comparison** (Question I, 14th Congress). Report *(Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey* and *Jugoslavia)* by O. LEDUC	361	**625** .142
IV. The **International Railway Congress Association** and the **Centenary of the Swiss Railways**	471	**385** (06 .119) & **385.** (093 (.4
V. OFFICIAL INFORMATION issued by the Permanent Commission of the International Railway Congress Association : **Meeting held by the Permanent Commission in Brussels, on the 15th February 1947.** *Appendix :* **List of Members of the Permanent Commission** (15th February 1947).	472	**385** (06 .111

	Pages.	Numbers of the decimal classification
No. 4. — APRIL 1947.		
I. Special Accounts summing up the Reports on the question for discussion at the fourteenth session of the International Railway Congress Association (Lucerne, 1947).		
Section I. — WAY AND WORKS :		
QUESTION I. — **Sleepers : a) different types; b) maintenance methods; c) financial comparison,** by J. VAN RIJN	481	**625** .142
Section II. — LOCOMOTIVES AND ROLLING STOCK :		
QUESTION II. — **Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : a) choice of the method of construction; b) use of special steels; c) use of alloys,** by J. DE AGUINAGA	487	**625** .2 & **669**
Section III. — WORKING :		
QUESTION III. — **As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day,** by E. F. Baron VAN HAERSOLTE	501	**656** .222.5
Section IV. — GENERAL :		
QUESTION IV. — **The interest the Railway Companies would have in building houses for their staff of all ranks, or in assisting the building of such houses,** by F. PINTO TEIXEIRA	506	**385** .517.7
Section V. — LIGHT RAILWAYS AND COLONIAL RAILWAYS :		
QUESTION II. (SECTION II) above applied to *Light Railways and Colonial Railways*	526	**625** .2 & **669**
II. The history of the centenarian Hungarian Railways, by Ladilaus VARGA	527	**385** (09 (.439)
No. 5. — MAY 1947.		
I. The interest the Railway Companies would have in building houses for their staff of all ranks, or in assisting the building of such houses (Question IV, 14th Congress). Supplement to report, by E. L. ANTONUCCI.	529	**385** .517.7
II. As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day (Question III, 14th Congress). Supplement to report, by M. LORRIOT	551	**656** .222.5

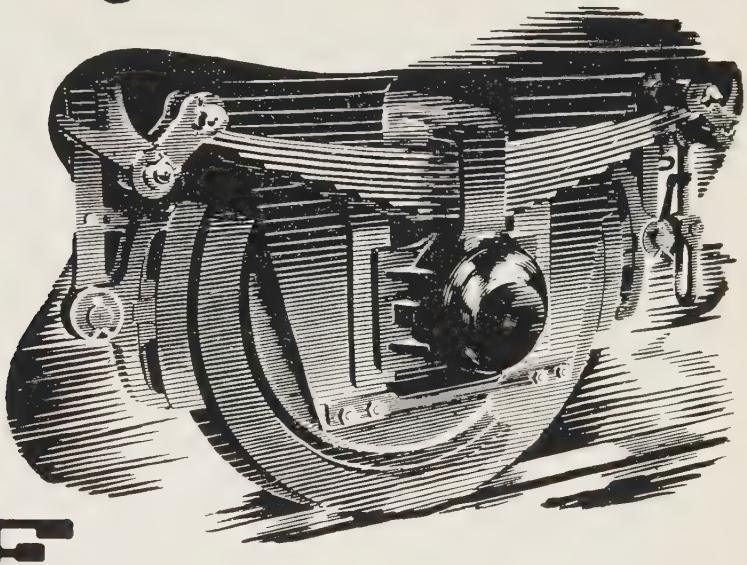
	Pages.	Numbers of the decimal classification.
No. 5. — MAY 1947. *(Continued.)*		
III. **The Swiss Federal Railways during the war,** by G. DREYER *(to be continued)*	555	**385.** (09 (.494)
IV. Research into the causes of **locomotive boiler explosions,** by M. CHAM.	583	**621** .133.3
V. **Gas turbines** for **traction purposes.** A summary of German developments.	586	**621** .438 (.43)
VI. MONTHLY BIBLIOGRAPHY OF RAILWAYS	17	**016.** 385 (02
No. 6. — JUNE 1947.		
I. **The Swiss Federal Railways during the war,** by G. DREYER *(concluded)*	591	**385.** (09 (.494)
II. Big **special track-work job** goes in smoothly, by T. H. BEEBE	610	**625** .144 (.73)
III. This new **ballast cleaner** is different	619	**625** .144.4 (.73)
IV. **Carryphone** in service on Pennsylvania, by W. R. TRIEM	624	**656** .254 (.73)
V. **Radio** in **railroad tunnels**	627	**656** .254 (.73)
VI. **Lighting « Trolley »** for enginehouses	629	**621** .138 (.42) & **621** .32 (.42)
VII. A. R. E. A. adopts 3 **new rail designs**	631	**625** .143.1 (.73)
VIII. Methods of improving **strength, durability and wear resistance of concrete**	637	**691.** (06 (.73)
IX. **Final summaries adopted at the XIVth Session** of the International Railway Congress Association (**Lucerne, June 1947**)	647	**385.** (06 .111
X. MONTHLY BIBLIOGRAPHY OF RAILWAYS	33	**016** .385. (02
No. 7. — JULY 1947.		
I. **Light railcars for colonial railways,** by J. L. KOFFMAN	655	**621** .431 .72 & **625** .61
II. **Safe stresses in axles.** Determination of axle shape and dimensions, by M. KAMMERER	674	**625** .212
III. **Tickets,** by Lionel WIENER. — *Part E* : Ticket representation of tariffs. Special tickets. *(Concluded.)*	685	**656** .234
IV. Large **concrete building takes a trip**	705	**725** .32 (.73)
V. NEW BOOKS AND PUBLICATIONS :		
Traité d'exploitation des transports *(Treatise on the organisation of transport)*, by P. DE GROOTE	711	**656.** (02
The locomotives of Sir Nigel Gresley, by O. S. NOCK	714	**621** .13 (09 (.42)
VI. MONTHLY BIBLIOGRAPHY OF RAILWAYS	49	**016** .385. (02

	Pages.	Numbers of the decimal classification.
No. 8. — AUGUST 1947.		
I. FOURTEENTH SESSION, LUCERNE 23-28 JUNE 1947.		
Summary of Proceedings.		
List of the papers published	718	385. (061 .12
Programme of events	720	...
List of the participating Administrations and affiliated Organisations	722	...
General list of delegates :		
I. Delegates of the Permanent Commission	726	...
II. Members appointed by adherent Governments and by affiliated Railway Administrations and Organisations	729	...
Alphabetical index of delegates who attended the Congress	740	...
Opening Ceremony of the Session	753	...
General Officers of the Session	760	...
Officers of sections	762	...
Programme of sectional meetings	764	...
Summary report of discussions in sections :		
Section I	766	...
— II and V meeting jointly	773	...
— III	784	...
— IV	795	...
Revision of the Rules and Regulations of the International Railway Congress Association	803	...
General meetings and closing ceremony	804 and 809	..
List of members of the Permanent Commission and Secretary's Office	812	...
Receptions, visits and excursions	815	...
No. 9. — SEPTEMBER 1947.		
I. **Individual axle drive.** Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds *(to be continued)*, by Adolphe-M. Hug	823	621 .337
II. **The oil firing of steam locomotives.** A survey of the present position in certain European and Overseas countries, by F. Strauss	837	621 .133.1
I. **Expediting miscellaneous traffic on the L.M.S.R.**	866	656 .226 (.42)
V. **The centenary of the Danish State Railways**	875	385. (09 (.489)
V. New books and Publications :		
4-8-2 class « 15 F » locomotives for the South African Railways	877	621 .132 .3 (.68) & 621 .132 .5 (68)

	Pages.	Numbers of the decimal classification.
No. 9. — SEPTEMBER 1947. *(Continued.)*		
Railway inspection	879	**385** .3 (.42)
The Railway Handbook, 1946-1947	880	**385.** (02
Railway Signalling and Communications. — Installation and maintenance	881	**656** .25 (.42)
L.N.E.R. Statistics. — Railways, Roads, Canals	882	**313** .385 (.42)
Longmoor Military Railway. — Transportation Training Centre of the Corps of Royal Engineers	882	**623** (.42)
VI. MONTHLY BIBLIOGRAPHY OF RAILWAYS	59	**016** .385. (02
No. 10. — OCTOBER 1947.		
I. **Individual axle drive.** Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds. *Chapter III (Continued)*, by Adolphe-M. HUG	885	**621** .337
II. **Asphalt ballast, welded rails, good drainage** solve this **station-track problem**, by John R. SCOFIELD	904	**625** .14 (.73)
III. **Norfolk & Western steam switcher has automatic controls**	911	**621** .132 .3 (.73) & **621** .132 .8 (.73)
IV. **Luzancy bridge, France**	918	**624** .63 (.44)
V. **The welded bridge over the river Birs, near Bärschwil, Swiss Federal Railways**, by F. BÜHLER	919	**624** .7 (.494)
VI. **What about our railroad stations?** By J.-C. SHERRICK	924	**725** .31 (.73)
VII. NEW BOOKS AND PUBLICATIONS:		
Les transports en Belgique depuis la libération, par le MINISTÈRE DES COMMUNICATIONS (Belgique). *(Transport in Belgium since the liberation, by the Ministry of Communications, Belgium)*	931	**656** (.493)
The « Liberation » locomotive — 2-8-0 type with double bogie tender for European use	933	**621** .132 .3 (.4) & **621** 132 .5 (.4)
The London Midland & Scottish Railway Company. — A record of large-scale organisation and management, 1923-1946	934	**385.** (09 (.42)
American Railway Signaling Principles and Practices. — *Chapter IV*: Centralized traffic control	936	**656** .254 (.73)
De IJzeren Weg. — Holland bouwt op. *(The Railway. — Reconstruction in Netherlands.)*	937	**385.** (09 (.492)
VIII. MONTHLY BIBLIOGRAPHY OF RAILWAYS	69	**016** .385. (02

	Pages.	Numbers of the decimal classification.
No. 11. — NOVEMBER 1947.		
I. **Fourteenth Session, Lucerne 23-28 June, 1947. General Proceedings in Sections and in Plenary Meetings.**		
1st SECTION. — **Way and Works :**		
Inaugural Meeting of the 1st Section	939	385. (06 .112
QUESTION I. — **Sleepers : a) different types ; b) maintenance methods ; c) financial comparison**	941	625 .142
2nd and 5th SECTIONS **meeting jointly :** 2nd *Section* : **Locomotives and Rolling Stock.** 5th *Section* : **Light Railways and Colonial Railways.**		
Inaugural Meeting of the joint Section	954	385. (06 .112
QUESTION II. — **Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : a) choice of the method of construction : b) use of special steels; c) use of light alloys**	956	625 .2 & 669
II. **Testing with Magnaflux on the D. & R. G. W.**, by RAY MCBRIAN.	986	625 .143 .3 (.73) & 625 144 .4 (.73)
III. **The development of locomotive power at speed**	992	621 .131.1
IV. **Conversion from coal to oil burning**	997	621 .133.1 (.42)
V. MONTHLY BIBLIOGRAPHY	81	016 .385. (02
No. 12. — DECEMBER 1947.		
I. **Individual axle drive.** Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds. *Chapter IV. (Continued)*, by Adolphe-M. HUG.	999	621 .337
II. **2-8-4 locomotive of the Roumanian State Railways**, by A. ZANESCO	1021	621 .132 .3 (.498)
III. **The Swedish State Railways**, by Arne SJÖBERG	1037	385. (09 (.485)
IV. Nine years of **strip welding on the New Haven**, by A. L. BARTLETT	1051	625 .143 .4 (.73) & 665 .882 (.73)
V. NEW BOOKS AND PUBLICATIONS :		
Cours d'exploitation des chemins de fer. *Tome II :* Exploitation technique. Signalisation. Enclenchements. Commande centralisée. Dispatching. *(Railway operating course. Vol. II : Equipment used in connection with traffic operation. Signalling. Interlocking. Centralised traffic control. Dispatching or Control of train movements)*, by U. LAMALLE.	1056	656 .25 (02
Association of American Railroads (A.A.R.). — American Railway Signaling and Practices. *Chapter II :* Symbols, Aspects and indications	1057	656 .251 (.73)
VI. Analytical table of articles according to the decimal classification	1 to 8	...
II. Contents of the 24th year of the English edition	I to VII	..

Reliability increased

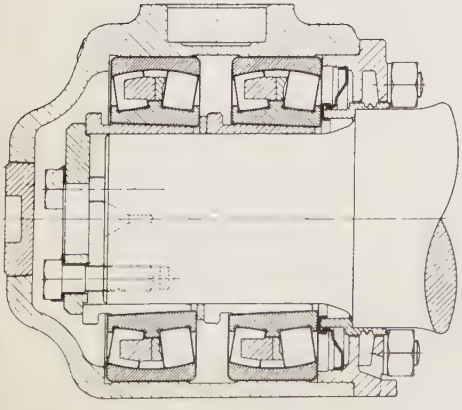


by the

SKF

GOODS-WAGON AXLEBOX

Railways in Holland, France, Spain, Czechoslovakia, Finland, Sweden, and other countries, have since 1941 ordered more than 100,000 **SKF** goods-wagon axle-boxes — a feature of the drive to rationalize goods transport.



SKF

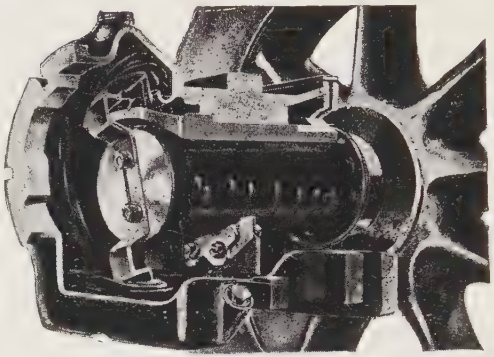
«ISOTHERMOS»

Axle box with mechanical lubrication

Bearing " Athermos "

Complete safety with any loads and at the highest speeds

•



Oil saving

No maintenance

Minimum coefficient of friction

•

Brussels - Société Générale " Isothermos " - Paris

9, rue du Moniteur **35, rue de la Tour d'Auvergne**

Agents or Representatives in all main countries

In Great Britain : J. STONE & Co. Ltd. Oceanic House - 1a, Cockspur Street, London S.W.1

Sté ANGLO-FRANCO-BELGE

DES ATELIERS DE LA CROYERE, SENEFFE ET GODARVILLE

Head Office : LA CROYÈRE (BELGIUM)

Telegrams : LOCOMORAM-LA CROYÈRE Telephone. 2 lines : LA LOUVIÈRE Nos. 44 and 1229

Carriages of every class and description. — Railcars, steam, electric, diesel oil locomotives. — Ordinary and special waggons. — Caboose cars and brake vans. — Tenders. — Crossings, switches and track material. — Boiler and plate work. — Forgings. — Heavy flanging.

S. A. LA BRUGEOISE et NICAISE & DELCUVE

Steel-works, Forges and Engineering Works

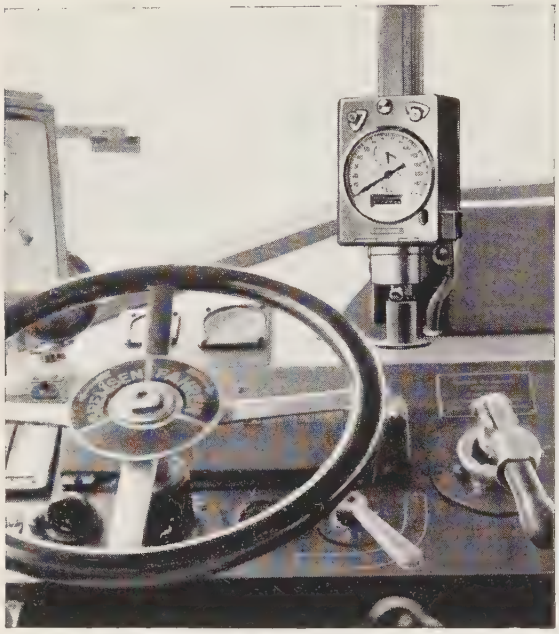
Works at St-Michel near Bruges and at La Louvière (Belgium)
General Management at St-Michel near Bruges

Rolling Stock and Fixed Equipment for Railways and Tramways

Bridges, Frames, Tanks
and all Metallic Constructions riveted and welded
Steel Castings of all kinds and qualities

Springs

Iron Foundry



The TELOC Speed Indicators and Recorders

are the product of experience since 1887 in the construction of speed indicators and recorders for railway locomotives and vehicles.
The new type TELOC indicates the speed, the total distance travelled, the time of day. It records on the chart the speed, distance travelled, the time in hours and minutes and the time and duration of stops. If required the instruments can also be fitted with apparatus to record the pressure in the brake pipes, the direction of travel and the passing of signals, etc.

Hasler SA Berne
MANUFACTURE D'APPAREILS TÉLÉPHONIQUES ET DE PRÉCISION
FONDÉE EN 1852 TÉLÉPHONE NO. 64

Alphabetical Index of Advertisers

Firms :		Specialities :
Anglo-Franco-Belge des Ateliers de La Croyère, Seneffe et Godarville (Soc.) .	III	Locomotives and Railway rolling stock.
Ateliers des Charmilles (S. A.)	—	Air brakes for railways and tramways.
Brown, Boveri & Co. Ltd.	—	Electric locomotives.
Brugeoise et Nicaise & Delcuve	IV	Railway rolling stock and fixed equipment.
Cockerill (John)	—	Machinery and metal structures.
English Electric Company, Ltd (The) .	—	Railway electrification.
Firth (Thos) & Brown (John), Ltd. . .	—	Railway forgings and tools.
Hasler (A. G.)	V	Speed indicators and recorders.
Isothermos (Société générale)	III	Axleboxes.
S. A. B. (Svenska Aktiebolaget Broms-regulator)	—	Automatic slack-adjusters.
S. K. F. (Société Belge des Roulements à Billes)	II	Axleboxes.
Usines Emile Henricot	—	Automatic couplers.

MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

[385. (05]

VOL. XXIV. — 1947.

NOTICE TO READERS

LIST OF ABBREVIATIONS OF MEASURES, ETC., USED IN THE *BULLETIN*

Kilometre	km.	Minute	m.
Metre	m.	Second	s.
Centimetre	cm.	Kilogrammetre	kgrm.
Square kilometre	km^2.	Kilovolt	kV.
Square metre	m^2.	Kilovolt-ampere	kVA.
Square centimetre	cm^2.	Kilowatt	kW.
Hectare	ha.	Kilowatt-hour	kW-h.
Are	a.	Watt	W.
Centiare	ca.	Horse-power	H. P.
Cubic metre	m^3.	Per cent	%
Cubic centimetre	cm^3.	Per thousand	‰
Stere	st.	Tonne-kilometre	tkm.
Hectolitre	hl.	Passenger-kilometre	p.-km.
Litre	l.	Train-kilometre	tr.-km.
Centilitre	cl.	Franc	fr.
Degree	°	Centime	c.
Minute	′	Lire	L.
Second	″	Centesimo	c.
Tonne (Metric)	t.	Pound sterling	£
Ton (English)	ton.	Shilling	s.
Hundredweight	cwt.	Penny	d.
Kilogramme	kgr.	Dollar	$
Gramme	gr.	Cent	ct.
Centigramme	cgr.	Reichsmark	Rm.
Hour	h.	Pfennig	pf.

MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

PUBLISHING and EDITORIAL OFFICES : 19, RUE DU BEAU SITE, BRUSSELS.

Yearly subscription for 1947 : { **Belgium . . . . . 700 Belgian Francs**
Universal Postal Union . 800 Belgian Francs

Price of this single copy : 125 Belgian Francs.

Subscriptions and orders for single copies (January 1931 and later editions) to be addressed to the General Secretary, International Railway Congress Association, 19, rue du Beau Site, Brussels (Belgium).

Orders for copies previous to January 1931 should be addressed to Messrs. Weissenbruch & Co. Ltd., Printers, 49, rue du Poinçon, Brussels.

Advertisements : All communications should be addressed to the Association, **19, rue du Beau Site, Brussels.**

CONTENTS OF THE NUMBER FOR JANUARY 1947.

CONTENTS	Page.
I. **Lightening the rolling stock. Reduction in the weight of rolling stock (passenger and goods) by : a) choice of the method of construction; b) use of special steels; c) use of alloys** (Question II, 14th Congress). Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by Eyre A. W. TURBETT	1
II. **As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day** (Question III, 14th Congress). Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by R. J. HARVEY	17

CONTENTS *(continued)*. Page.

III. **As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities. To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day** (Question III, 14th Congress). Report (Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburgh, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey, Jugoslavia), by M. LORRIOT 29

IV. **Sleepers : a) different types; b) maintenance methods; c) financial comparison** (Question I, 14th Congress). Report (America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt), by J. C. L. TRAIN 49

V. **Gas turbines** for railway **traction** 143

VI. MONTLY BIBLIOGRAPHY 1

LIBRARY

OF THE

Permanent Commission of the International Railway Congress Association.

READING ROOM : **19, rue du Beau Site, Brussels.**

Works in connection with railway matters, which are presented to the Permanent Commission, are mentioned in the « Bulletin ». They are filed and placed in the library. If the Executive Committee deems it advisable they are made the subject of a special notice. Books and publications placed in the reading room may be consulted by any person in possession of an introduction delivered by a member of the Association. Books, etc., may not be taken away except by special permission of the Executive Committee.

The Permanent Commission of the Association is not responsible for the opinions expressed in the articles published in the Bulletin.

All original articles and papers published in the Bulletin are copyright, except with the consent of the Authors and the Committee.

An edition in French is also published.

VOL. XXIV. — No 1. January 1947.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[625 .2]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

14th. SESSION (LUCERNE, 1947).

QUESTION II.

Lightening the rolling stock.

Reduction in the weight of rolling stock (passenger and goods) by :

a) choice of the method of construction;

b) use of special steels;

c) use of alloys.

REPORT

(America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt),

by EYRE A. W. TURBETT,
Assistant Chief Mechanical Engineer, Southern Railway.

The lists hereafter give a summary, compiled from the replies to the Questionnaire on the above subject, received from the following Railway Companies:

Great Western Railway. London, Midland & Scottish Railway. London & North Eastern Railway. Southern Railway. London Passenger Transport Board.	Great Britain.
Association of American Railroads. Bessemer & Lake Erie Railroad Company. The Baltimore & Ohio Railroad Company. The Pennsylvania Railroad. Reading Company.	United States of America.
Ceylon Government Railway.	
Great Indian Peninsula Railway. North Western Railway.	India.

Iraqi State Railways.
New Zealand Government Railways.
Kenya & Uganda Railways & Harbours.
Sudan Railways. } Africa.

The Association of American Railroads state that the information supplied by them will serve as a reply for all Railways in the United States of America, who received a copy of the Questionnaire, other than such lines as may elect to reply direct.

The South African Railways and Harbours gave general comments on the subject in question.

(1) — VEHICLES CARRYING PASSENGERS OR FREIGHT VEHICLES i. e. LUGGAGE AND BAGGAGE CARS RUNNING IN PASSENGER TRAINS.

(1a) Wheels and axles.

QUESTION.	SUMMARY.
What diameter wheel is considered standard ?	For the metre gauge 28½″. For the 4′8½″ gauge the diameters vary from 31″ to 43½″.
What is the width of the tyre ?	Metre gauge 4½″. For standard 4′8½″. Gauge vary from 4½″ to 5½″.
Are they tyred wheels or one wear wheels ? i.e. the tread or tyre on integral part of the wheel centre. If the former, of what material is the wheel centre made ?	Tyred wheels are mostly used with steel centres.
Of what material are the axles made ? i.e. grade of steel or alloy steel.	Majority use steel 35 to 40 tons per sq. in. tensile.
Do you use hollow axles ? *If so, are they :* *Forged ?* *or* *Machined from solid ?*	No. Hollow axles believed to have been originally introduced in the U.S.A. Proposed for future 36″ dia. wheels on the Great India Peninsula Railway.

(1b) Axleboxes.

What type of axleboxes are used ?	Solid or divided type of axlebox mostly used with half bearing.
Have you any constant ratio-weight of axleboxes with size of journal ?	No.
Are roller bearing axleboxes used ?	Roller type bearing is slightly in favour. Roller bearings are generally adopted as modern practice in the U.S.A., Ceylon, New Zealand, Iraqi and the London Passenger Transport Board. Other railways have only reached the experimental stage by having a few vehicles fitted.

Of what material are the axleboxes made; cast iron, cast steel or fabricated electric welding process ?	Use of cast iron to specification or cast steel equally divided. Fabricated electric welding of axleboxes. Fabricated construction is in the development stage in the U.S.A. The London Passenger Transport Board and Ceylon Railway have also had experience of this method of construction.

(1c) Springs.

How many individual spring nests or groups of springs are used between the bolster and the axlebox ?	2 groups mostly favoured, dependent on design of truck.
What is the combination of such springs, coil, i.e. helical or volute, elliptic or half elliptic ?	Combinations vary between coil, half elliptic, elliptic, and volute springs.
Are any anti-vibration pads used of rubber or other synthetic materials ?	The use of rubber pads is slightly favoured.

(1d) Bogie frames.

What type of bogie frame is considered standard ? i.e. equalising beam type ?	Bolster swing link suspension with springs over axleboxes mostly favoured.
Single or double bolster ? Without springs plank ?	Single bolster with spring plank favoured.
Is the bogie frame of cast steel, fabricated and rivetted or fabricated and welded ?	Fabricated frames rivetted or welded are mostly favoured. Fabricated and welded frames. The U.S.A. have this type of construction in the experimental stage. It has also been adopted as modern practice by the London Passenger Transport Board, London Midland and Scottish (Gt. B.) and New Zealand Railways.

(1e) Bogie brakework.

Are all wheels braked ?	Yes.
How many blocks per wheel ?	Two blocks per wheel.
Of what material are the brake blocks ?	Cast iron.
Are the brakes solid or renewable blocks keyed to brake holders ?	Renewable blocks keyed to holders mostly used.
The assumption relating to the foregoing is that the braking effort is applied on the tread of the wheel ?	Yes.

What is the experience (if any) of either disc or drum braking of the auto-motive type ?	None. Some in development stage. Drum braking. U.S.A. have this type of braking under consideration and is in the development stage. The G.W. R. (Gt. B.) have used drum brakes on Diesel cars, but results have not proved as satisfactory as brakes applied to the tread of wheels.
Is the braking power obtained by individual cylinder per wheel ?	No.
What medium is used therein : air, vacuum, hydraulic or electric pneumatic ?	Use of air or vacuum equally divided.
What is the cylinder pressure lb./sq. inch of the medium used ?	Air varies from 50 to 90 lb. per sq. inch. Vacuum varies from 9 to 11 lb. per sq. inch.
Are any of the above details made of special steels, ferrous or non-ferrous metals ?	No.
Which details of the brakegear are fabricated by electric welding process ?	Majority of cases there is no electric welding, but four companies electrically weld brake shaft arms to shafts.

(1f) Underframes.

What is the principle of your design ? e.g. is the theorem that the primary stresses in the underframe are those due to « paying load » or buffing and drawgear shocks ?	Generally calculated on the paying load plus buffing and drawgear shocks.
Is it held that underframe should be of sufficient strength in itself to withstand these stresses or is the underframe and the body or superstructure considered as a combined unit ?	Generally. Underframe itself.
How are the shocks due to the buffing and drawgear dissipated through the frame; e.g. is it considered they are resisted by the whole vehicle structure ?	Generally through the underframe only.
Is the centre girder type of underframe, with side sills for supporting and attaching the body or superstructure, preferred to the solebar type (two per frame headstock to headstock) and constituting the main members of the structure ?	Opinions are equally divided between the two methods, and it would appear the centre girder is coming into favour. U.S.A. generally adopt the centre girder type.

In considering the strength of the solebar type frame, what portion of the stresses due to the various forces, are viewed as being absorbed by the longitudinal members, thereby reducing the stresses in the solebar ?

Where longitudinals are continuous between the bogie centres they are considered as carrying a proportional share of the load with the solebars. Where longitudinals are not continuous the solebars are taken as carrying the whole load.

Are any special high tensile or rustless steels used ?

The majority do not use special high tensile or rustless steel. U.S.A. railways — Yes.

Special high tensile and rustless steels. U.S.A. railways are making extensive use of stainless and low alloy, high tensile steels in the construction of underframes. Aluminium has also been used for underframe members.

If so, which members of the underframe are made thereof ?

Where special high tensile steels are used they are incorporated in the main underframe members, such as, solebar, longitudinals, diagonals and cross members.

Is cast steel used for any unit portion of the underframe ? e.g. headstock to bolster.

Steel castings are not used in the majority of cases. U.S.A. sometimes use cast steel draft sill and/or bolster.

Alternatively, are any of the members made of ferrous or non-ferrous alloys ?

Generally — No.

Are the underframes assembled by electric welding process ?

The majority appear to prefer rivetting of underframes.

U.S.A. — Yes when steel is employed.

Electric welding of underframes is the modern practice employed by the London Passenger Transport Board, L. M. & S. and L. & N. E. Railways of Great Britain. It would appear that it is frequently adopted in the U.S.A. but only as far as practicable. Sudan Railways have the matter under consideration for future underframes.

(1g) Draw and buffing gear.

What is the standard type; side buffers, with hook drawgear, or centre coupler ?

Opinions are equally divided between side buffers with hook drawgear and centre coupler.

What is the spring medium; i.e. steel or india rubber ?

Opinions appear to be equally divided on the use of rubber or steel springs.

Is the gear in alignment with the longitudinal centre line of the underframe or below the headstock ?	50 % have gear in alignment with centre line of underframe. 50 % have gear below centre line of underframe.
Is the drawgear pull on the end longitudinal or behind the bolster ?	Drawgear pull on the end longitudinal is favoured by a small majority.
Are the buffers self contained, mounted on the headstock ?	Where self contained buffers are used they are mounted on the headstock.
Do you consider buffers of the self contained type being of less weight than buffers mounted with springs behind headstock ?	Opinions appear to favour the self contained buffer being of less weight than buffers mounted with springs behind headstocks.
Are any special high tensile steels used for the drawgear ?	Special high tensile steels for drawgear are not used by the majority of Companies, but is favoured by the U.S.A.
Is an aluminium alloy used for the buffer cases or sleeves ?	No.
Are the buffer heads electric welded to the buffer shank or stem ?	No.
What portion, if any, of the drawgear is fabricated by « resistance welding method » ?	None.

(1h) Foundation brake rigging.

What type of brake cylinder is mounted, air, vacuum or hydraulic ?	Type of brake cylinder mounted is about equally divided between vacuum and air.
How many cylinders are used per frame ?	2 cylinders per frame are mostly used.
What percentage of the tare weight of the respective type of vehicle is considered desirable, e.g. 85 %, 75 % or 65 % ?	Percentages vary from 65 % to 90 % with two exceptions.
Are any special steels of high tensile properties used ?	No. Except in interest of weight reduction.
Of what material are the brake cylinders ?	Majority manufactured in cast iron. Whereas the general practice is to use cast iron or steel, it is interesting to note the U.S.A. Railways have in some cases used aluminium as the material for the manufacture of brake cylinders.

Is electric welding process used in the fabrication of the levers, fulcrum brackets and pull rods ?	Generally no.

(1i) Heating, steam and electric.

What is the medium used for heating coaching stock — steam or electric ?	Steam for steam stock. Electric power for electric stock.
In either case, whence the source of supply ?	From locomotive for steam stock. From power supply for electric stock. From steam generator on diesel locomotives.
Of what type are the through coupling hoses — india rubber or non-ferrous flexible tubing ?	India rubber is more generally used. Flexible metallic connectors are also used.
Are lavatory water heaters installed ? If so, what type and location thereof ?	Water heated mainly by steam water, heaters situated above or below basin. Others heated at water supply tank or electrically heated where power is available.
What is the material used for the main piping in the case of the steam heating ? The size thereof and the weight per foot run ?	Steel piping is more generally used varying from $1\frac{1}{2}''$ to $2\frac{1}{2}''$ bore.
What material is used for the insulation lagging of the main steam pipe ?	Asbestos appears to be slightly preferred to hair felt.

(1j) Electric lighting equipment.

What is the system ? i.e. dynamo drive from the axle, feeding accumulators or is a generator set fitted ?	Dynamo drive from axle feeding accumulators is common practice for steam stock. Motor generator set is used for electric stock.
In the instance of the latter, where is the generator set located — on the underframe or in the body ?	Where used, generators sets are in all cases mounted on the underframe.
What is the type of lead — braided fabric or lead covered, in the instance of the former, are they housed in metal conduits ?	Generally braided fabric is used and only in a few instances are they housed in metal conduits, the latter principally in the U.S.A.

(1k) Air conditioning equipment.

Is air conditioning equipment fitted ?	Not generally fitted, except in U.S.A. modern stock. It appears that the fitting of air conditioning, is practically universal in all modern equipment of the U.S.A. Railways, whereas in other countries it is only fitted on a few special vehicles or in the experimental stage.
If the answer is in the affirmative, from which of the foregoing electrical supply sources is this drawn ?	Electrical supply drawn from axle driven dynamo and batteries.
Where is the location of the ejection of conditioned air into the compartments ?	The most common location of the ejection is the centre of ceiling, but in three cases the position is floor level.
Of what material is the ducting manufactured ?	Steel is the most common material used.
What material is used for the insulation lagging thereof ?	A slight preference is shown for hair felt, but asbestos, cork, or fibre glass is used to a lesser degree.
Confirm or otherwise if double glazing of all windows is adopted in connection with air conditioning.	Double glazing of all windows appears to be the general practice.

(1l) Body construction.

Of what type is the standard vehicle i.e. compartment, corridor vestibule or saloon vestibule with lavatory accommodation ?	Generally all three types with lavatory accommodation are in use on main line services.
If of the former, is there a body side door to each compartment ?	Opinions seem to be divided on the practice of fitting side doors to each compartment. It appears however, that there is a tendency in new stock to dispense with a side door to each compartment.
Are the vestibules fitted with doors attached to the body ends ?	Yes.
In the instance of the bodies of the vehicles being made of steel, what are the physical properties thereof ?	Mild steel average 50 000 lb. per sq. inch tensile.
Are any synthetic and/or light materials used in building up the main framing ?	No.

With what material is the exterior of the body framing covered ?	Steel panels of 16 S.W.G. appear to be in common use. The U.S.A. Railways have occasionally used aluminium.
In the instance of steel body framing, is electric welding process generally adopted ?	The practice of electric welding steel body framing appears to have been adopted by 50 % of the railways concerned.

(1m) End vestibule through communication.

What type is the end vestibule through communication ?	Enclosed flexible diaphragm.
Is the vestibule mainly supported on the body end, or is the stress taken back into the body roof framing ?	Supporting vestibule gangway on the body end appears to be the general practice. Some are supported on body and underframe.
Are any special steels used in the construction thereof ?	No.
Of what material is the collapsible fabric ?	Canvas is mostly used. To a lesser degree rubber, leather and rexine cloth are also in use.
To what extent is electric welding process adopted in the manufacture of the vestibules ?	The practice of electric welding seems confined to the fabrication of detail parts.

(1n) Passenger accommodation.

Generally speaking, is the passenger seating arranged transversely across the vehicle or longitudinal ?	Transversely is the common practice.
In the instance of the compartment type stock, what are the dimensions between the partitions, and seating space per passenger for the various classes of stock ?	Distance between partitions. 1st. class vary from 6′2″ to 7′6″. 2nd. and 3rd. class vary from 5′0″ to 6′8″. Seating space per passenger. 1st. class vary from 1′8″ to 2′2″. 2nd. and 3rd. class vary from 1′3″ to 2′0″.
In the instance of the saloon type stock with transverse seating, what are the dimensions between the seat backs ?	Back to back seats, 1st. class 7′0¼″ to 7′4″. 3rd. class 5′8″ to 6′10″. Seats facing in same direction. 1st. class approx. 4′0″. 2nd. and 3rd. class vary from 2′3″ to 3′6″.
Is this dimension intended to include the space for fitting portable tables ?	In the case of back to back seats. Yes.

(1o) Lavatory accommodation.

What are the number of lavatories per standard vehicle ?	Varies with class of accommodation but 2 lavatories per car seems to be the general practice.
Of what type are the main fittings ?	Porcelain.
Is stainless steel used for the manufacture thereof ?	Very seldom.

(1p) Heating elements.

What is the type of heater element used in both lavatories and compartments ?	Gilled or fin type radiators in compartments. Lavatory heater adopted to suit.
Efficiency : How many cubic feet per square foot of heater element ?	Vary from 8.75 to 40 cub ft. per sq. ft.
Is the heating system under control of the passenger ?	In the majority of cases — Yes.
State briefly the location of the heater element.	Position is either under compartment seat or along body side or floor in saloons.
What material is used for the making of the heater elements ?	Steel tube is mostly adopted, U.S.A use copper.

(1q) Interior decoration and type of seating.

Briefly, what is the scheme of decoration ?	There is no general scheme, it depends on the railway company and type of vehicle. Materials used are polished veneer panels, rexine covered panels, cellulose lacquer, pastel shades of paint. Ceilings painted white or cream.
Are stainless steel mouldings or facias used ?	Very rarely used.
Please state if any other synthetic light materials, e.g. plastics other than timber or fancy veneers on plywood are used.	Yes. Occasionally on a few railways.
Are the seats built up on timber or steel framing or are they manufactured as a separate unit covered with the upholstery ?	Generally timber and separate units.

Are the seats adjustable ?	Chiefly — No. Except in the U.S.A. On the Pennsylvania Railroad the latest innovation is the adoption of rotating and reclining seats.
Are loose cushions fitted ?	About 50 % use loose cushions.
Are arm rests provided both at the body side and also to divide the seats ?	General practice to provide in 1st. class.
In the instance of the seat framing being of steel, what are the physical properties thereof ?	Chiefly mild steel. 50 000 lb. per sq. inch.
State any other light materials used in the construction of the seats and seat backs.	Aluminium used occasionally, on the U.S.A. Railways and seats frames for the London Passenger Transport Board.

(1r) Interior metal furniture.

Of what material are locks, latches, parcel racks or commode handles manufactured ?	Latches and locks. Brass. Parcel racks. Aluminium, brass or steel. Commode handles. Aluminium, brass.
In connection with any of the aforementioned details, are they fabricated by electric welding process ?	No, except in a few cases for seats frames.

(1s) Electric light fittings.

What is the type of illumination : bulkhead, bracket or fluorescent ?	Bulkhead lighting is the main type. Bracket type almost as common. Increasing use of fluorescent lighting.
Of what material are the electric light fittings made ?	Fittings : Brass, plastic, bakelite, steel. Shades : Glass or plastic.

(2) — FREIGHT VEHICLES, OPEN AND COVERED, FOR THE TRANSPORT OF MINERALS, GENERAL MERCHANDISE AND EDIBLE FOODS

(2a) Wheels and axles.

Is the diameter and general dimensions of the wheels used for freight vehicles, the same as the wheels used for passenger stock ?	Not usually the same, except on a few Railways.
If the answer is in the negative, give dimensions.	U.S.A. : 33″. Great Britain : 37″ average. Others : From 28″ to 30″.

Are solid (one wear) wheels with the tread or tyre an integral part of the wheel centre used ?	Mostly solid (one wear) wheel type, but a number are fitted with tyres later.
If the wheels have removable tyres, what is the type of tyre securing ?	Retaining ring, largely Gibsons. Sudan and Ceylon Railways use tyres shrunk on to wheel centres and secured by set screws. Indian Railways favour the Glut ring fastening.
Of what material are the axles made ?	Steel similar to BSS. Report 24 — Part 1, Specification No. 3. 35-40 tons tensile.
Are hollow axles used ?	Only used experimentally by some Railways (U.S.A.).

(2b) Axleboxes.

What type of axleboxes are used ?	Except U.S.A. Railways, open front and divided types. U.S.A. Railways, cast steel integral with side frames.
Have you any constant ratio : weight of axlebox with size of journal ?	Few only have a constant ratio for this.
Are roller bearing axleboxes used ?	Very few used for special cases and experimental. Experimental stage on U. S. A. Railways and Kenya and Uganda Railways.
Of what material are the axleboxes made : cast iron, cast steel or fabricated electric welding process ?	Cast steel generally. L. M. S. R. and L. & N. E. R. (Gt. Br.) and Ceylon Railway are the only Companies which appear to have used fabricated and electric welded axleboxes.

(2c) Springs.

How many individual spring nests or groups of springs are used between the bolster and the axlebox ?	Various; between 1 group and 8 groups. 1 or 2 groups generally used.
What is the combination of such springs, coil, i.e. helical or volute elliptic or half elliptic ?	Vast variation.

(2d) Bogie frames.

What type of bogie is considered standard ?	Diamond frame and built-up type mainly.

Is the bogie frame of cast steel, fabricated and rivetted or fabricated and welded ?	Cast steel and fabricated and rivetted most common. Few fabricated and welded. L. M. & S. R. (Gt. B.) and New Zealand Government Railways appear to be the only Companies who have used fabricated and welded bogie frames.
(2e) Bogie brakework.	
Are all wheels braked ?	Yes.
How many blocks per wheel ?	One usually.
Of what material are the brake blocks ?	Cast iron.
Are the brakes solid or renewable blocks keyed to brake holders ?	Both solid and renewable blocks are equally used.
The assumption relating to the foregoing is that the braking effort is applied on the tread of the wheel ?	Yes.
What is the experience (if any) of either disc or drum braking of the auto-motive type ?	None.
Is the braking power obtained by individual cylinder per wheel ?	No.
What medium is used therein : air, vacuum, hydraulic or electric pneumatic ?	Air or vacuum are the common mediums.
What is the cylinder pressure lb. sq. inch of the medium used ?	Air : 50-70 lb. per sq. in. Mostly about : 50 lb. per sq. in. Vacuum : 9-11 lb. per sq. in. Mostly about : 10 lb. per sq. in.
Are any of the above details made of special steels, ferrous or non-ferrous metals ?	*Very few* are made of stainless steel, etc.
Which details of the brake-gear are fabricated by electric welding process ?	Triangular bars, pull rods, fulcrum levers, brake lever, brakeshaft, vee hangars, brake beams, brake cylinder carriers, brake shaft carriers, on British type railways mainly. None on American type railways.
What system of handbrake on four-wheeled vehicles is considered satisfactory ?	Drop lever type more in general use.
(2f) Underframes.	
What is the principle of your design ? e.g. is the theorem that the primary stresses in the underframe are those due to « paying load » or buffing and drawgear shocks ?	The principle of design in most cases is that the primary stresses in the underframe is due to both paying load and buffing and drawgear shocks.

Is it held that the underframe should be of sufficient strength in itself to withstand these stresses, or is the underframe and the body or superstructure considered as a combined unit ?	U.S.A. take underframe and body as a combined unit. Other Railways, underframe considered strong enough in itself.
How are the shocks due to the buffing and drawgear dissipated through the frame, e.g. is it considered they are resisted by the whole vehicle structure ?	Resisted by underframe only.
Is the centre girder type of underframe with side sills for supporting and attaching the body or superstructure, preferred to the solebar type (two per frame headstock to headstock) and constituting the main members of the structure ?	U.S.A. Railways — centre girder type. Other Railways — solebar type.
In considering the strength of the solebar type frame, what portion of the stresses due to the various forces, are viewed as being absorbed by the longitudinal members, thereby reducing the stresses in the solebar ?	Two standard methods : (1) Proportional to sizes of sections. (2) Approximately 85 % to 100 %.

(2g) Draw and buffing gear.

What is the standard type side buffers, with hook drawgear, or centre coupler ?	U.S.A., centre coupler. Other Railways, side buffers with hook drawgear.
What is the spring medium, e.g steel or india rubber ?	Steel springs are mostly used.
Is the gear in alignment with the longitudinal centre line of the underframe or below the headstock ?	Usually in alignment or very near.
Is the drawgear pull on the end longitudinal or behind the bolster ? Or is continuous drawgear used ?	End longitudinal mainly.
Are the buffers self contained, mounted on the headstock ?	Self contained buffers are not in the majority, but where used are mounted on the headstock.
Do you consider buffers of the self contained type being of less weight than buffers mounted with springs behind headstocks ?	Self contained buffers are considered less weight, but only slightly less.
Are any special high tensile steels used for the drawgear ?	Yes — but only for a few details.

Is an aluminium alloy used for the buffer cases or sleeves ?	No.
Are the buffer heads electric welded to the buffer shank or stem ?	No. Except on New Zealand Government Railways where buffer heads are electrically butt welded to main shank.
What portion, if any, of the drawgear is fabricated by « resistance welding method » ?	None, except for 3-link couplings on English Railways and central buffer on New Zealand Government Railways.

(2h) Foundation brake rigging.

What type of brake cylinder is mounted, air, or vacuum ?	Both types are widely used.
How many cylinders are used per frame ?	Generally one, on some of the larger bogie types, two.
What percentage of the tare weight of the respective type of vehicle is considered desirable, e.g. 85 %, 75 % or 65 % ?	Vary between 20-100 %. Average 75 % (about).
Are any steels of high tensile properties used ?	No. Except on U.S.A. Railways, where high tensile steels are used.
Of what material are the brake cylinders ?	Cast iron mainly. Pressed steel brake cylinders are used by the Iraqi State Railways.
Is electric welding process used in the fabrication of the levers, fulcrum brackets and pull rods ?	Not generally used. All British Railways adopt electric welding of levers to brakeshafts and fulcrum brackets, and to a limited extent is in use by the Kenya and Uganda Railways.

(2i) Body construction.

Of what material is the construction of mineral wagons ?	Steel mainly. U.S.A. Railroads have made use of aluminium but only in the experimental stage.
What arrangement of doors is regarded as standard ?	Very varied arrangements of doors. Drop down bottom door. Double side opening top doors most common.
Of what material are the bodies of the following vehicles constructed. *1. Open goods wagons ?* *2. Covered goods wagons ?* *3. Brake vans ?*	1. Steel mainly. 2. » » 3. Timber.

State what material for floors is considered most satisfactory for covered vehicles for the transport of :
1. General merchandise.
2. Feeding stuffs.
3. Edible foods such as non-refrigerated fish.

It appears that for (1) general merchandise and (2) feeding stuffs, either timber or steel is considered most satisfactory. For (3) edible foods, such as non-refrigerated fish, timber is preferred. Steel or composition floors being preferred by a few Railways.

Has aluminium or light alloys been used succesfully for body construction ?

No. U.S.A. Railroads have the application of aluminium or light alloys in the experimental or development stage, and the North Western Railway (India) and Kenya and Uganda Railways are contemplating its use as a trial measure.

(2j) Materials for insulating perishable goods and refrigerator vans.

What is considered the best material for insulating purposes against extremes of temperature having regard to the non-inflaminable qualities ?

The most used materials for insulating are : cork, onazote, fibre glass and kapok.

What thickness of insulation is required having regard to the kind of material used, and maximum temperature ?

The insulation that is in general use is as follows : Cork, 2″ to 3″ thick. Glass fibre, 3″ to 5″ general. Glass fibre, 6″ to 8″ for special frozen foods. For hot climats : kapok, 9″ to 12″, cork, 9″.

In the case of refrigeration, what equipment is in general use ?

Equipment for refrigeration in general use is ice bunkers or ice chests.

(2k) Ventilation.

What is the best means of ventilating vehicles ?

Roof vents and end or side louvres are generally considered the best means of ventilation.

Are roof ventilators considered satisfactory ?

Roof ventilators are considered satisfactory.

Of what bore or diameter should they be for air extraction ?

Diameter hole for air extraction varies between 3¾″ and 4½″, but U.S.A. use 6″ × 24″ opening.

(2l) Heating elements.

Are coal burning stoves considered the best means of heating guard's and brake vans ?

Coal burning stoves are generally considered the best means of heating guards' and brake vans.

Is steam generally used for heating vans used for special traffic ?

Yes. Steam heating is generally used where heating is necessary, with one or two exceptions.

[656 .222 .5]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

14th. SESSION (LUCERNE, 1947).

QUESTION III.

As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities.

To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day.

REPORT

(America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt),

by RANALD J. HARVEY,
Consulting Engineer to the Government of New Zeeland.

In view of the wide scope of the report called for, my colleague Monsieur LORRIOT and I decided that a more co-ordinated survey would result if inquiries were sent out to constituent Members in the form of a Questionnaire. This was done, and the results of the enquiry thus made are embodied in the report which follows.

In all, replies to the Questionnaire were received from forty-five Railways. Of these twenty came from the U.S.A., eight from India, five from Great Britain, four from South America, four from Africa, and one each from Australia, New Zealand, Burma, and Iraq, representing between them 187 000 miles of open lines.

Your Reporter's warmest thanks are due to his Colleagues in these Railways for the care and time they have expended in preparing their very lucid replies, which have rendered his own task so much the less onerous. He fully realises these are hectic days of trying to catch up on arrears of work, of reconstruction, and rehabilitation; and an uphill struggle to regain normality. Any

extra work such as is involved in the researches necessary to provide accurately the information asked for in the Questionnaire could not have been anything but an added burden upon an already overworked personnel. All the more honour to them for their response. Even Burma, whose Railways probably suffered more from enemy action than any other, came forward with all the information available to them.

In considering the replies regard has to be had to the fact that 1945 is in many ways not precisely a fair basis on which to found a comparison with pre-War conditions. For more than two thirds of it the world was at War, and the Railway Transport industry was working at highest pressure, and invariably under abnormal operating conditions. Those systems which were actively engaged in the movements of munitions of War, or the materials to make them; and of vast numbers of troops, had perforce to sacrifice temporarily many principles of economic operation, in their all-out effort to do their share — or a bit more — towards bringing the War to as early a conclusion as was compatible with complete victory.

There are few, if indeed any, Railways which were not directly affected in one way or the other. Even those not so immediately concerned with the effects of an enormously increased volume of traffic suffered disabilities in the difficulty of obtaining adequate supplies of suitable fuels, and of material for renewals, replacements, and the maintenance and upkeep of the rolling stock which they had in service. Even, also, road services suffered from lack of tyres and essential spare parts.

In these circumstances it was inevitable that many schemes of progressive development, and numerous experiments which by now would have been carried out, had to go into temporary « cold storage ». It was, in short, a period of « mend and make do », and it seems probable that these conditions will obtain, though on a gradually decreasing scale, until the next International Congress.

With these considerations in mind your Reporter has endeavoured, in his analysis of the replies received, to place the situation before you in such a form as to provide a basis of comparison from which deductions may be made. He has thought that in laying before you the broad facts, unencumbered by masses of comparative statistics, discussions will be instigated in the Congressional Meetings which will prove of much greater mutual help than could be got from a long and more detailed written analysis.

Turning now to the actual replies :

I. — GENERAL QUESTIONS.

QUESTION 1. — *In considering your system as a whole what is the extent of your coaching traffic represented in terms of :*

(a) Percentage of total receipts from all traffic.

(b) Passenger miles.

(c) Regular train mileage divided into steam traction, electric traction, and rail cars.

(The figures asked for should be those for the last pre-War year [1938] and 1945.)

(*a*) In thirty-seven out of the forty-five reports, the percentage of total earnings attributable to coaching traffic shows an increase. The only exceptions showed comparatively small decreases, and are all on systems which normally rely upon coaching traffic for a large share of their earnings.

On the whole the average is round about 45 % increase over the percentages of 1938, but, for reasons mentioned

earlier in this report, these comparisons are not to be regarded as generally indicative.

(*b*) As might be expected from these replies, the passenger miles equally show a considerable increase, the only exceptions being those which showed a decrease under (*a*) above.

(*c*) In addition to their steam services twenty-eight systems use both electric traction and rail cars; three have additional electric traction only; and five have additional rail car services only.

Of those operating electric traction two have only had them installed since 1938, and consequently no comparative figures are available. Where comparison can be made it would seem from the answers given that the development of electric traction, though considerable, is not anything like as great as might have been expected. This almost certainly is the result of the wartime difficulty of getting on with development schemes at all. The greatest advances are shown by the *Atchison, Topeka and Santa Fe Railway; Chicago and North Western Railway; New York, New Haven and Hartford Railroad,* and *New Zealand Government Railways,* and it would be most interesting to hear the Representatives of these Railways on this subject.

In the matter of rail car services, (to which further reference will be made later under another question heading), the results are most conflicting. In ten cases there are increases, and on eight railways the services have decreased. Again it would be most informative to hear individual statements.

QUESTION 2. — *What is the average number of passengers per passenger train mile ?*

It is noticeable that in every single case the number of passengers per train mile shows an increase, an indication of the heavier loading which became universal during wartime. Those of us who were in Great Britain throughout the War have lively recollections of the bitter complaints of overcrowding which overwhelmed us like an avalanche.

QUESTION 3. — *Can you give the proportion of total working expenses attributable to coaching traffic, if so, what is the percentage ?*

This question is one which presents difficulties. Many systems do not attempt to apportion the working expenses between coaching and goods; and those who do so do not always adopt the same basis of estimation, which makes comparison difficult.

It occurs to your Reporter, that at some time, a small sub-committee might be nominated to study this question, and to make recommendations for a standard method of estimation which could be universally adopted. A late distinguished Member of our Congress, Mr. Alec Newlands, Chief Civil Engineer to the London Midland and Scottish Railway, in his book, *The British Railways,* made a gallant attempt to solve this — and some similar railway statistical problems, — in a pratical manner which might be applied to any Railway system.

QUESTION 4. — *Have you experimented with light high speed trains with a view to increasing your passenger traffic, and if so, what have been the results from the following points of view :*

(a) Financial : (if returns have been kept what results have they shown) ?

(b) Attractiveness to passengers.

(c) Road competition : has this been reduced and to what extent ?

Of the forty-five Railways under review nineteen have made experiments of this nature, and of these seven report enthusiastically upon the successful results achieved from all three points of view : four from the United States, two from India, and one from Australia.

Ten others, of which seven are in the United States, report great success, but have no statistical records on which to base an answer to the question of the effects upon road competition. It would seem that this method of countering the attractiveness of road traffic has had most success in the United States, and the evidence is so strong that it should encourage other systems to experiment.

The least effect upon road competition has been the cessation of expansion : in some cases it is practically eliminated. Where successfully tried out the trains employed have been of a luxury type designed to encourage traffic, not only by high speed, but by additional comfort and other amenities. In conditions favouring this form of transport it is evident from the reports submitted that there is an immediate public response to trains combining higher speed and increased comfort. Speed alone does not appear to produce the same results.

QUESTION 5. — *Have you tried to compete with road traffic on particular routes by the institution of frequent rail car services, and if so, what have been the effects under the headings* (a), (b), *and* (c) *as above ?*

In all, twelve systems have tried the use of rail cars to counter road competition. In the aggregate the results have been disappointing. British Railways find that the rail car services do not give the flexibility required, and have substituted « push and pull » units, in which the accommodation provided can be varied at will to meet the local requirements. These have been found very successful.

QUESTION 6. — *Are you in favour of the suspension of a substantial number of your passenger services, and if so, what were the regular annual train/passenger miles of the trains you propose to abolish ?*

The answer to this question is an almost universally emphatic « No ». Only five systems favour this method of economy, of which four are in the U.S.A. Two Railways are contemplating increasing the number of train miles to be cut out, but it must be borne in mind that, in forty-five Railways representing five Continents there is necessarily so wide a range of varying traffic conditions that what might be a prudent measure of economy in some areas would be a disaster in others.

It is a matter which can only be dealt with on the individual merits.

QUESTION 7. — *To what extent have you altered the scale of fares ? What are your present comparative third class fares (based on currency exchange in gold) ? What were the rates in 1913 and 1938 on the same basis ?*

Throughout the world, as represented by the Railways which come under this review, fares have been raised to a greater or lesser extent. Methods of fixing fares vary widely, and to attempt to classify them, and then to tabulate them in a form which would enable just comparison to be made would be to burden reader with pages of figures. Equally, in these days of fluctuating exchange values, your Reporter hesitates to essay the task of reducing them to a gold basis, and of drawing conclusions which might not, by the time this report appears, bear a proper relation to actuality. The simple fact remains that, with only

five exceptions, all the Railways have increased their fares in their own currency.

Of the five exceptions noted, four have made no change, or no appreciate change, and one — *Kenya and Uganda Railway* — has actually found it possible, and advisable, to reduce fares, partly to retain traffic, and partly because of its improved financial position.

QUESTION 8. — *What regular passenger train mileage do you envisage in the near future, say 1948 ?*

There is a general, and, if your Reporter may be allowed to say so, a natural inclination, in all quarters, to foresee a considerable increase in passenger train mileage.

II. — TIME TABLES.

A. — Main lines.

QUESTION 9. — *What are your ideas for main line day and night services ? Considering lines with easy gradients not exceeding 6 %, are you in favour of :*

QUESTION 10. — *Heavy trains 650-700 tons with an economic running speed of 45/50 miles per hour ?*

QUESTION 11. — *Lighter trains 450-500 tons at an economic running speed of 55/60 miles per hour ? Or :*

QUESTION 12. — *Are you in favour of using both to the best advantage, and what means would you employ to achieve this ?*

There is a wide diversity of replies and opinion on the subject covered by these questions.

The British Railways find the speeds suggested too low, and the loads too heavy for commercial operation in Great Britain, and moreover, station and terminal accommodation are not designed to cope with trains of such length. They favour much higher speeds than those quoted in the Questionnaire.

It is very evident, from studying the replies received, that here again, is a problem for the solution of which no general recommendation can be made. Each correspondent has, most naturally, answered the query in the light of the operational conditions obtaining on his own Railway, and the replies vary between the extremes of light slow trains, and fast heavy ones, with every grade of combination coming between. As an overall view, opinion is best summed up in the phrase which appears most generally :

« The best use of all types of train according to local traffic circumstances ».

There appears, however, to be one general tendency, and that is the direction of higher speeds.

QUESTION 13. — *Are you in favour of linking up large centres by means of special services with extra amenities in the shape of higher speeds and additional comfort ? In such a case would you be in favour of making a supplementary charge to cover the extra operational expenses incurred ?*

This question is in two parts.

In the answers to the first portion the general view is in favour, and the method is already in operation wherever traffic conditions call for it, (which incidentally is nearly everywhere).

Opinions on the application of supplementary fares vary considerably, but on the whole favour such charges, particularly where the trains occupied in such services offer amenities, such as

air conditioning, and other costly luxuries, in addition to high speed. It would seem that whenever such services are feasible and practicable their institution has been successful from all angles.

QUESTION 14. — *Are you in favour of combined trains made up of coaches allocated to various stations on different branch lines ?*

Here again opinion is very divided : nineteen Railways are in favour, fifteen appear definitely opposed, and others do not find such an arrangement suitable for their actual operating conditions.

The real answer is to be found in favourable or unfavourable local conditions.

QUESTION 15. — *Are you in favour of through coaches ?*

Here the reply is an almost unanimous vote in favour. The few systems which do not use through coaches are operating in conditions which render them unnecessary, or impracticable, by reason of change of gauge, or other physical difficulty. It is clear from the replies that wherever operating conditions made them useful or practicable, they are in universal use.

QUESTION 16. — *Are you in favour of developing sleeping car services, and if so in which classes ?*

All those whose operating conditions make a sleeping car service a practical economic proposition are in favour, and already have them installed, and are satisfied with the results achieved.

From the general trend of the answers it is easily gathered that opinion is in favour of extending their use to second — and even third — class accommodation : but at the moment in the majority of cases first class only is in use.

QUESTION 17. — *Do you use rail cars on your main lines, and if so do you use them as non-stops, or as stopping services ? Do you use them to link up stations not served by normal through trains ?*

Only eleven of the systems using rail cars employ them on main line services, and in practically every case they are used as stopping runs. Occasionally non-stop runs appear, but these are rare.

Very few Railways replied to the third part of the question, but since rail cars are used it would seem natural to expect that one of the services would be linking up all stations not having the advantage of normal through trains.

QUESTION 18. — *Do you use electric motor traction units outside suburban lines ? If so please give examples.*

On this question eleven Railways use electric traction units outside suburban lines. A most striking example is the Southern Railway in Great Britain which operates more than 350 miles of route outside suburban areas, and is extending still further.

The Pennsylvania Railroad Company, and several other American Railways use electric locomotives on certain lines outside suburban areas. It would seem to be clear that the extension of electric traction outside suburban areas is limited to those Railways serving chiefly very densely populated areas.

B. — Branch lines.

QUESTION 19. — *How do you operate your branch line network ? What frequency of service do you provide ?*

The universal answer to this is that branch line services are scheduled entirely according to local traffic requirements, which, in themselves, vary on the same system, from one branch line to another. Frequency of service varies accordingly.

A strong point is made, in every case under review, of the importance of timetables being arranged to connect with the main line services at larger stations. It would be impossible to make a general statement suggesting the most favourable frequency. Each system and each branch adjusts its branch services to its local conditions.

QUESTION 20. — *Do you operate any of them by rail cars, if so, of what seating and other capacity ? e.g. baggage.*

Most Railways employing rail cars make use of them only on branch lines. The power of the cars used and their seating capacity vary within wide limits according to individual Railways and their operating conditions.

A fair general average might be taken at about 200 hp. and 50 seats with appropriate accommodation for baggage etc.

QUESTION 21. — *Do you operate mixed services, that is passengers and freight ?*

Your Reporter confesses to some surprise at discovering from his analysis of replies received that not less than thirty-five out of the forty-five Railways which have replied use mixed services. Details of the actual circumstances are scarce, but it is perfectly obvious that such trains are considered an integral and economic component of the general services provided. It is a point upon which the views of individual Delegates would be most welcome.

QUESTION 22. — *Has the co-ordination of road and rail transport been attempted, if so, has this enabled you to eliminate passenger services by rail ? Also, what is the mileage of the lines on which this has been done ?*

A highly interesting question, upon which it is certain that every Delegate holds strong views. In so far as the replies are concerned it is abundantly clear that this problem has exercised the minds of all our Members. The attempts at the solution are numerous, but the general consensus of opinion appears to be in favour of rail companies acquiring substantial holdings in the more well-established and successful road service Companies which were their competitors; or the adoption of a system of co-operation by interchangeability of rail and road tickets.

An interesting sidelight is the apparent strong objection held by Oriental Governments to their Railway systems co-operating on a commercial basis with road passenger transport companies. The most striking example is India, where replies indicate that the discouragement shown by Governments to attempts to marry rail and road services has led to the abandonment of otherwise promising mutual arrangements.

Your Reporter hesitates to pursue this aspect further, feeling that he is treading on political ground, but the view of the Delegates from the originating systems would be most interesting.

In Great Britain the problem of co-ordination — at least as far as passenger services are concerned — of rail and road has been most successfully solved by mutual financial interests which have naturally led to mutual working arrangements.

On the whole, where active attempts at co-operation have been successfully made, little or no mileage of rail has been affected. Great Britain, with her

system of simultaneous financial and operational co-operation easily heads the list of economy of no less than 900 miles of rail transit. The Denver and Rio Grande Western Railroad also reports extensive and successful co-operation.

Your Reporter suggests that in the light of the somewhat sketchy outline given above, a Congressional discussion might produce some most illuminating information.

QUESTION 23. — *Alternatively, if on certain routes passenger traffic has been reserved to rail, what is the mileage of road service on the routes effected thereby ?*

This is another controversial matter.

In an effort to bring road and rail together various Governments have endeavoured to protect one or the other by methods of restrictive legislation whereby traffic in certain areas, or on certain routes, was reserved to rail or to road.

It is not a method favoured by the legislation which affects the systems coming under this review. On only four lines does any such restriction apply; and where figures are given, (in three cases only) total lengths reserved to rail amount to only 768 miles. It is quite unimportant in comparison with the 187 000 miles reported upon.

C. — Suburban lines.

QUESTION 24. — *Are your suburban services run on regular frequencies, e.g. 10, 15, 20 minutes, etc. ?*

QUESTION 25. — *If so, are these services provided by regular sets of trains, each train of the set being allocated to its own zone, or its own series of stations ? What services do you provide in slack periods and at what frequency ?*

Universally the answer is that the timetables of such services are governed entirely by local traffic conditions; efforts being made to meet requirements as they arise, and to encourage development by additional attractions.

QUESTION 26. — *Do you use heavy steam trains in shuttle services ?*

Answers are almost equally divided, the only conclusion to be arrived at after the most careful study of the replies received is that wherever traffic and operating conditions justify shuttle services, they are in use. In no case has any objection been raised to the principle.

QUESTION 27. — *What is the normal composition of your suburban trains on electrified lines ? Do you vary composition according to the time of day and the consequent traffic ?*

Here again it has proved impossible to lay down a general average standard. Composition of train sets (and equally the frequency of services, referred to under *Question 25.*) are varied according to the local conditions of intensity of movement to be arranged for.

QUESTION 28. — *What is your present rolling stock position :*

(a) full complement ?

(b) in service ?

What was the position in 1938 ?

There are different aspects of this question varying from Railways with short mileages and very heavy coaching traffic, to others with long mileages and light traffic. It has proved impossible to find a common basis to which all systems might be referred for comparison. An attempt to do so by averaging establishment to mileages produced such

conflicting results, that no useful purpose would be served by recording them.

A similar attempt to co-relate establishment with train and passenger mileages was more promising in results, but the amount of statistical analysis which would be required to arrive at any satisfactory basis would be, in the Reporter's opinion, incommensurate with the value of the information derived. On a general overall survey it is quite safe to say that the establishments in 1945 show a considerable reduction from that of 1938, a result which is only to be expected from the difficulties previously referred to of obtaining new stock, or replacements, during wartime.

III. — Material.

QUESTION 29. — *What is the average weight of your main line steel bogie coaches, 1st., 2nd., and 3rd. class ? What are their seating capacities ?*

On the whole steel coaches in Great Britain and the U.S.A. are heavier than those in the other countries represented in the review, but the number of seats and the design and layout of corridors varies considerably according to the class of coaching traffic catered for. A rough general estimate may be taken at 1 ton per seat 1st. class.

QUESTION 30. — *Have you in service or under consideration bogie coaches built of light weight metal alloys, if so what are their types and their weights in comparison with steel coaches of similar capacity ?*

Another highly interesting question.

The general leaning is increasingly towards experimenting with reducing the deadweight haulage by the use of light weight material. Nevertheless nineteen systems report that they have not yet tried. Four have the question under consideration, but have not yet proceeded further with it. Among those interested the most popular material is an aluminium alloy, achieving considerable reduction in weight for equivalent strength. It is beyond doubt that the incidence of War with its attendant difficulties has very greatly retarded experimentation on this very important subject.

The views of the Delegates of the Railways which have been fortunate enough to have been able to experiment would be invaluable to those Representatives whose Railways are still considering the question.

QUESTION 31. — *Have you in service or under consideration secondary line coaches of two or four axles ? If so, what are their weights, seating capacities, and interior arrangements, e.g. central or lateral corridors, baggage, accommodation, etc. ?*

Very few lines, and then those only operating in exceptional conditions appear to have in service, or under consideration such small coaches as integral parts of their establishments. The tendency would appear to be entirely towards standardising bogie coaches.

IV. — Rail cars.

QUESTION 32. — *Are you in favour of single Units (no trailers), of low horse-power (say up to 150) and small seating capacity (say up to 50) ?* Or :

The consensus of opinion on this question is emphatically « No ».

A few Railways have experimented, but unsuccessfully, and judging from the replies it must be taken that small low powered single units are not looked upon with general favour.

QUESTION 33. — *Larger and higher powered cars, say 600 horse-power and upwards ? If so, for what type of service would you contemplate their use, and with what, if any, types of trailer ?*

Generally the larger cars are preferred, and are treated as small train units. *The North Western of India* has found high-powered large cars most successful, and this is attributed to their comparatively large seating capacity, coupled with increased speed which these high-powered motor units enable them to achieve.

QUESTION 34. — *What is the average horse-power of your rail cars ? Are they single units only, or can they be used to haul one or more trailers ? On what services do you use them for preference ?*

The variation in horse-power is considerable from 180 H.P. to 750 H.P. In general the higher powered rail cars are designed for use with trailers which can be added to them when traffic requirements call for the increased capacity. About 250 H.P. to 300 H.P. would represent the average.

V. — Staggering of passenger traffic peaks.

QUESTION 35. — *Has any legislation in force in regard to paid holidays, holiday camps, etc., resulted in increasing the ordinary unavoidable summertime traffic peaks ?*

Only in eight cases, of which three are in the U.S.A., two in South America, and one each in Ceylon, South Africa, and New Zealand has the incidence of paid holidays, etc., resulted in increasing ordinary summertime peak traffics. All other systems report either no increase, or no legislation enforcing paid holidays.

QUESTION 36. — *Are you in favour of staggering holidays and similar occasions in order to flatten the resulting traffic peaks ?*

In fourteen instances, the verdict is in favour, while seventeen systems express themselves as opposed. Of the others, opinion is that in their local circumstances, it is not practicable, or is not required.

QUESTION 37. — *Do you cancel any special reduced fares during such peak periods ?*

The answer is almost unanimously in the negative. It is evidently not a popular procedure.

QUESTION 38. — *Do you in such circumstances arrange for relief express trains which may run on other routes and timings in order to ensure fullest use and quickest turn round of stock ?*

Opinion is very divided on this point, fifteen Railways, including all British systems, five in U.S.A., three in Argentine, and one each in Ceylon and Egypt follow this practice. The remaining lines do not find it necessary. It is obviously a matter of traffic requirements.

QUESTION 39. — *Do you during such periods operate any trains in which accommodation must be reserved beforehand, passengers who have not made reservations being systematically directed to other trains ?*

The majority of the Railways under review adopt a system of reservations, whereby in special circumstances trains are reserved for passengers who have pre-booked their accommodation, such trains being generally run as «Specials».

QUESTION 40. — *Do you operate a system of advance booking for certain*

trains by the issue of reservation tickets to the number of seats available ?

Practically every Railway operates a system of advance booking. Only five, out of the whole of the number of answers received, do not. These cases are usually when local traffic does not call for it.

QUESTION 41. — *Do you prohibit holders of reduced fare tickets from travelling by particular trains ?*

Just a half of the Railways replying prohibit the use of reduced fare tickets on particular trains : twelve do not, and the remainder make exceptions in certain cases.

QUESTION 42. — *Do you allow any special facilities to railway employees and their families ?*

With only four exceptions the custom of giving privilege travelling to Staff is in force, though, in many cases with limitations governed by length of service, and by restrictions in the number of free, or reduced fare tickets granted per annum.

QUESTION 43. — *Is your rolling stock « establishment » designed to cope with a certain peak traffic, and if so what is the percentage of increase of that peak above normal traffic ?*

In general, the replies indicate that establishment is designed to cope with a certain peak traffic which averages about 25 % above normal. When circumstances are favourable certain systems find it possible to meet traffic emergencies by borrowing from neighbouring systems whose peak traffic does not coincide with their own.

[656 222 .5]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

14th. SESSION (LUCERNE, 1947).

QUESTION III.

As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities.

To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day.

REPORT

(Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburgh, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey, and Yugoslavia),

by M. LORRIOT,

Ingénieur en Chef, Chef de la Division Centrale du Mouvement-Voyageurs à la Société Nationale des Chemins de fer français.

CHAPTER I.

General.

For Railways throughout the world the passenger train services represent an important part of the traffic to which they are naturally inclined to make improvements, under pressure from the Public Authorities and the demands of the public, without taking into exact account the financial results of such improvements.

In 1938, when the French National Railways were created, this important question was considered by the Management, who considered it essential to endeavour to draw up a balance sheet for the passenger services. The receipts

from these services, easily determined, amounted to 4 207 million frs., or 27 % of the total receipts; the expenditures, a more difficult matter to determine, were estimated, on the basis of certain hypothesis and various assumptions, to be 8 245 million francs, or 53 % of the total expenses. Consequently these services were the cause of a deficit of 4 000 million francs, about a quarter of which was made good by the goods services, since the latter showed a profit of about 1 100 million francs.

It would appear that all the European passenger services were in like plight in 1938, as the following table shows, at least as far as the countries which have tackled the problem and could supply statistics are concerned :

Country.	*Percentage of passenger receipts compared with total receipts.*		*Percentage of passenger costs compared with total costs.*	
	1938	*1945*	*1938*	*1945*
A) *Countries which took part in the war.*				
Belgium	33 %	48 %	51 %	41 %
Denmark	53 %	51 %	—	—
France	27 %	53 %	47 %	32 %
Italy	38 %	65 %	—	—
Norway	47 %	53 %	—	—
Holland	56 %	78 %	—	—
Poland	26 %	59 %	38 %	—
Jugoslavia	25 %	49 %	—	—
Rumania	25 %	17 %	43 %	24 %
B) *Neutral countries.*				
Portugal	35 %	32 %	—	—
Sweden (State Rys.)	33 %	40 %	—	—
Switzerland (Swiss Federal Rys.)	43 %	54 %	—	—

The situation improved considerably during the war, and it appears that in 1945 the percentage of passenger receipts compared with the total receipts had increased in *nearly all countries*, whether they took part in the war or remained neutral. At the same time the percentage of passenger service costs compared with the total expenditure decreased. In France, for example, the percentage of passenger receipts increased from 27 to 53 %, whereas the percentage of passenger costs fell from 47 to 32 %, while in Belgium the percentage of receipts increased from 33 to 48 %, and the costs fell from 51 to 41 %. This is not surprising; in effect, between 1938 and 1945, in nearly every country, the railways, owing to the prevailing fuel shortage, found it necessary to reduce their passenger train services, and on the other hand, there was an appreciable decline in the goods traffic. In addition, road transport, owing to the shortage of tyres and petrol, had to curtail its activities considerably, which restored to the railways a large part of the passenger traffic lost to this competitor. If on the other hand, we consider the figures given in the following table, which gives the passenger trains mileage (tr.-km.), the passenger kilometre (p.-km.) and the average train user (which is its quotient), for the different years :

It will be noticed that, generally speaking, from 1926 to 1938, there was a continuous increase in the passenger train mileage in all European countries, whereas the passenger mileage remained stationary or showed a definite tendency to fall off; the result was that nearly everywhere the average passenger train user fell off considerably during this period, until it reached a definitely unfavourable figure. For example, in France the average passenger train user fell from 121 to 77, and in Belgium from 161 to 96, while in Sweden where there is a particularly good passenger train service it fell from 80 to 60, so that in the end there was bound to be a deficit in the passenger service receipts, which the goods services had to make good if the general equilibrium was to be maintained.

If on the other hand, we compare the results obtained in 1938 and 1945, it will be found that the passenger train mileage has been reduced in every country except Sweden and Switzerland, whereas in every country, whether it took part in the war or remained neutral, the average passenger train user has increased to a marked degree, and in certain cases even reached completely abnormal figures (520 in Italy and 447 in France); this was obviously due to the shortage of fuel and the considerable reduction in the road services.

The general considerations given above would seem to indicate that the Railways should profit by the present situation to maintain the present balance, at least to some extent, and so organise their passenger services in the future that at least they are not the cause of too great a deficit, even if they are not a source of revenue.

	1926			*1935*			*1938*			*1945*		
	tr.-km.	*p.-km.*	*a.tr.-u.*	*tr.-km.*	*p.-km.*	*a.tr.-u.*	*tr.-km.*	*p.-km.*	*a.tr.-u.*	*tr.-km.*	*p.-km.*	*a.tr.-u.*
A) *Countries which took part in the hostilities.*												
Belgium	39 100	6 300	161	55 700	5 400	97	62 400	6 000	96	23 400	5 000	213
Denmark	—	1 080	—	23 200	1 500	64	23 700	1 550	65	9 400	2 600	276
France	233 000	28 270	121	264 900	22 600	85	284 800	22 050	77	66 400	26 100	447
Italy	86 700	6 500	76	105 500	7 700	73	117 800	11 100	94	16 100	8 380	520
Norway	—	—	—	—	—	—	15 200	740	48	12 200	1 080	87
Holland	31 100	3 100	100	39 400	2 900	74	41 100	3 100	75	11 000	3 600	327
Poland	54 800	6 000	109	64 100	5 500	86	75 000	7 500	100	38 000	10 500	276
Jugoslavia	17 600	2 000	114	20 400	2 200	108	25 900	3 000	116	11 000	3 550	323
Rumania	30 500	3 460	113	34 950	2 850	81	47 150	3 800	80	7 800	3 150	402
B) *Neutral countries.*												
Portugal	4 600	—	—	8 000	—	—	7 900	680	86	4 700	1 260	244
Sweden (State Rys.)	15 700	1 260	80	25 600	1 870	73	38 600	2 330	60	55 900	5 400	96
Switzerland (Swiss Federal Rys.)	23 600	—	—	29 600	—	—	34 200	2 870	83	35 400	5 650	159

Train/km. (tr.-km.) : in thousands of km. Passenger/km. (p.-km.) : in millions of passengers. Average train user = a.tr.-u.

In order to extend or at least conserve their passenger traffic and consequently the passenger receipts, certain Railway Companies took certain steps before the war, which in practice were found to be ineffectual.

For example, the French National Railways multiplied the passenger services on certain lines and introduced new fast services of limited capacity, while on other lines railcar services at frequent intervals were introduced to meet road competition. A detailed analysis of the financial results of such experiments has proved that the increase in expenditure was considerably greater than the additional receipts earned.

Similar experiments were also made in several European countries, for example Sweden, Switzerland, Belgium, and Italy. Generally speaking these innovations where liked by the public, but no strict balance sheet seems to have been prepared, nor proof of the favourable financial results obtained. In particular, the Belgian Railways, like the French National Railways, came to the conclusion that the corresponding increase in expenditure was not covered by the additional receipts. On the other hand, it does not appear that road motor competition was seriously affected by this increase in the passenger services.

Consequently, we are of the opinion that a remedy for the unfavourable passenger service balance sheet should not be sought in such measures, but on the contrary some other remedy must be found.

The following measures, in our opinion, might be found to remedy the situation :

1) a revalorization of the passenger fares;

2) a severe limitation of the regular passenger train services, in conjunction with :

a) a rational train service;

b) drawing up the train timetables according to a new policy;

3) lightening passenger rolling stock;

4) spreading out peak periods of passenger traffic.

In addition, although this very complex question does not come within the scope of the present report, it is necessary to obtain rational co-ordination of rail and road transport, so as to do away with competitive services, particularly on the main arteries, close down the passenger services on secondary lines with very little traffic, and have the same fares in operation for both methods of transport.

In the present Report, we propose to consider each of the above points, and endeavour to draw therefrom useful conclusions for the future.

* * *

CHAPTER II.

Revalorization of passenger fares.

In most of the countries which took part in the two world wars, since 1913 the gold value of the 3rd class fare per kilometre has shown a marked tendency to fall; the same phenomena can be seen in certain countries which remained neutral, for example in Portugal.

The following table gives the gold value for the years 1913, 1938 and 1946 :

	1913	*1938*	*October 1946*
A) *Countries which took part in the wars.*			
Belgium	0.0378	0.02812	0.0458
Denmark	0.0275	0.0242	0.0344
France	0.05	0.0318	0.0384
Italy	0.058 tr. directs 0.0522 tr. omnibus	0.03218	?
Norway	0.0222	0.02837	0.046
Holland	0.034	0 to 150 km. = 0.0386 151 to 300 km. = 0.0288 > 300 km. = 0.0144	0 to 140 km. = 0.0372 > 140 km. = 0.0186
Poland	.....	0.05	0.0621
Rumania	0.0452	0.0309	0.0134 (1)
Jugoslavia	0.04	0.023	0.036
B) *Neutral countries.*			
Portugal	0.047	0.022	0.022
Sweden (State Rys.) (Decreasing scale by zones) 10 km.	0.042	0.038	0.038
500 km.	0.0288	0.0287	0.026
Switzerland	0.052	0.0525	0.063

(1) in 1945.

tr. directs = through trains. tr. omnibus = stopping trains.

This reduction is in no way surprising; in most of the above mentioned European countries, the national money has fallen in value and the cost of living, generally speaking, if certain items be excluded, has constantly increased; naturally the Authorities have endeavoured by every possible means to minimise the consequences of this fall in the value of money, and in particular, they have tried to some extent to prevent passenger fares from being raised. On the other hand, the cost of raw materials and wages has been directly affected by the increase in the price of all goods and these have been increased more or less proportionately to the increase in the cost of living.

The result of this situation is that in most of the countries which took part in the war, the passenger fares are too low, and fall a long way short of the figure necessary to cover the total cost of the passenger services. It might be objected, strictly speaking, that in those countries where the money has fallen in value, the financial charges of the railways have also, *ipso facto,* been lightened, but in our opinion this is not a sufficient reason to justify the fares being too low.

On the other hand, in those countries which remained neutral, the passenger fares were maintained at the old rates, or even slightly increased (Switzerland).

We think that this is an important problem which should be studied, and each Railway Company should make its own investigation into the question in order to revise the passenger fares and bring them into line as far as possible with those in force in 1913; this has just been done in Belgium, Norway, Poland and Denmark.

However, it must not be overlooked that when the rates vary, the receipts attain a maximum, and for a given average user, there is a series of rates

giving the *maximum profit,* a scale possibly different from that giving the maximum receipts.

* * *

CHAPTER III.

Limitation of the regular passenger train services. — Organisation of the services.

The table on page 31/15 showed how the average user of passenger trains fell off nearly everywhere during the period 1926-1938, whereas the passenger train mileage increased almost continuously; it would appear therefore that this same mistake must not be repeated in the future, and consequently, the services must be reduced to a considerable extent.

For example in the new timetables which will come into force in France in 1948, this reduction has been estimated at approximately 48 %; the daily passenger train mileage which amounted to 790 000 km. (490 884 miles) in 1938 will be reduced to about 410 000 km. (254 762 miles) in 1948, and it is expected that under these conditions, taking into account the amount of passenger traffic at the present time, the average train user will fluctuate around 200.

To clarify their ideas on the matter, the French National Railways have investigated the total cost price, i.e. including all the items of expenditure, including capital charges, of the passenger train kilometre, making a distinction on the one hand between fast and express trains, and through trains, stopping trains and railcars on the other, and keeping the results obtained in the case of steam operated lines distinct from those of the electrically operated lines.

The results of these investigations are given in the following table :—

	Year 1938.				
	Steam trains.		*Electric trains.*		*Railcars.*
	Tonnage.	*Cost price.*	*Tonnage.*	*Cost price.*	*Cost price.*
Fast and express trains	376 t.	47 fr.	397 t.	50 fr.	29 fr.
Through and stopping trains	216 t.	42 fr.	331 t.	42 fr.	15 fr.
	Year 1946.				
Fast and express trains	482 t.	380 fr.	635 t.	520 fr.	205 fr.
Through and stopping trains	212 t.	290 fr.	348 t.	310 fr.	105 fr.

The total costs for 1946 were obtained by multiplying those of 1938 by the coefficient 7, which corresponds at the present time to the average increase in wages and raw materials, and by increasing the prices in the same proportion as the increase in the tonnage shown up in the above table; in fact, in comparison with 1938, the weight of the fast and express trains has been increased on both steam (28 %) and electrically (60 %) operated lines.

In the case of supplementary trains, i.e. those put in service without any new expenditure other than the cost of traction and train staff, the costs are as follows :

	Year 1938.				
	Steam trains.		Electric trains.		Railcars.
	Tonnage.	Cost price.	Tonnage.	Cost price.	Cost price.
Fast and express trains	376 t.	12 fr.	397 t.	6 fr.	7 fr.
Through and stopping trains	216 t.	12 fr.	331 t.	10 fr.	7 fr.
	Year 1946.				
Fast and express trains	482 t.	100 fr.	635 t.	60 fr.	50 fr.
Through and stopping trains	212 t.	80 fr.	348 t.	70 fr.	50 fr.

Taking into account the fact that in October 1946 the return per passenger-kilometre is about 1 fr. 22, to meet the total cost price, it is necessary to have an average user of 300 passengers in the case of fast and express trains on steam operated lines and 400 on electrically operated lines; we have however taken into consideration the fact that, at the present time, passenger fares are too low in France, if they are compared with those in force in 1913, and we have agreed that it is not necessary to go below a figure of 200 passengers for the average user of fast and express steam trains and 260 for fast and express electric trains. These factors were used by the French National Railways as guiding principles in drawing up the passenger timetables for 1946.

Without carrying out such a detailed investigation, most of the European Railways have nonetheless felt the necessity of avoiding the methods of pre-war days and of putting a brake on the constantly increasing train services offered before 1939. For example, the Algerian and Belgian Railways are in favour of very strict limitations of the services, and the Italian Railways recognise that it will be impossible to revert to the pre-war services. Even the Swedish and Swiss Railways, whose countries remained neutral during the war, have stopped multiplying the train services. The Railway Administrations, who have been consulted about their intentions for the future in this connection, in the most favourable cases, do not intend to go beyond restoring the pre-war services to their 1938 level (Sweden, Portugal, Switzerland, Italy), while others are considering a fairly extensive reduction of the train mileage (Belgium, Poland, Austria).

Taking this general trend into consideration, how are the European Railways drawing up the timetables for their various lines ?

A distinction must be made between main lines run over by fast and express trains, secondary lines and suburban lines.

a) Main lines.

In *France*, these services will be covered in the day time by 2 or 3 heavy express trains (650 tonnes [639.734 Engl. tons] in the case of steam traction, and 750 tonnes [738.155 Engl. tons] in the case of electric traction, on easy gradients), at an average speed of 70 to 75 km. (43 to 47 miles) per hour, and in the night time by 1 or 2 heavy express

trains, of similar speed, with sleeping cars. This service will be completed during the summer by a certain number of temporary express trains for the additional holiday traffic, to give the necessary services to health resorts, watering places and the seaside. In addition provision has been made to run 3 or 4 shuttle services of stopping trains, during the day time, which can be partially replaced, if need be, by railcars (usually two 300 H.P. cars coupled together). Finally, on the most important lines, such as Paris-Lyons-Marseilles-Nice, Paris-Lille, Paris-Bordeaux, Paris-Strasbourg, Paris-Le Havre and Paris-Basle, these services will be completed by 1 or 2 trains or express autotrains (1st and 2nd class) in each direction, which will be lighter (350 to 400 t. [344 to 393 Engl. tons]), run at higher speeds (120 to 130 km. [74 to 80 miles] per hour) and very comfortable; these trains are intended to provide the fast and frequent services required by businessmen and foreigners; to meet the extra cost involved, a small supplement will be charged for travelling in these trains, at least in the case of 2nd class passengers. Naturally, in addition to these internal services, there will be the important international expresses, such as the « Simplon-Orient Express », the « Orient Express », the « Arlberg Express »,etc., the frequency of these depending upon the extent to which they are used.

This idea of how to operate the main lines appears to be accepted by all the European Railways. For example :

— in *Sweden,* between Stockholm and Goteborg, provision has been made for 3 heavy express trains and 1 lighter fast train during the day and 1 or 2 express trains by night with sleeping cars;

— in *Poland,* provision has been made for one heavy express train by night and 2 or 3 faster express trains by day;

— in *Switzerland,* the services will be covered by a comparatively large number of heavy through trains and light fast trains, this being made possible by the electrification of the whole system;

— in *Italy,* provision has been made for 1 or 2 heavy express trains at night and lighter and faster trains by day;

— in *Algeria,* provision has been made for one 300 to 350 t. (295 to 344 Engl. tons) express train by day running at an average speed of 60 to 65 km. (37 to 40 miles) per hour, and one 400 to 450 t. (393 to 442 Engl. tons) express train by night running at an average speed of 50 km. (31 miles) per hour.

However, several Railway Administrations have pointed out that the railway equipment and layout was not always designed to handle very heavy and consequently long trains, and that it is not advisable to exceed a tonnage of between 600 and 700 t. (590 to 689 Engl. tons).

In all cases the express train services will be completed by 2 or 3 shuttle services of stopping trains, which will sometimes be replaced by railcars or autotrains.

In addition, the Railways are generally in favour of the idea (Belgium, Holland, Poland, Sweden, Switzerland, Norway, Italy) of linking up certain important towns during the day by the use of powerful railcars (800 H.P. and over), or electric cars, at very high speeds (120 to 140 km. [74 to 85 miles] per hour), generally with facilities for serving meals; such services are already being run in France between Paris and Lille, Paris and Strasbourg, Paris and Le Havre, and Paris and Lyons using autotrains or railcars, which enable the businessmen, these services cater for, to reduce their travelling time to the minimum.

Generally speaking the Railways agree upon the advisability of running through carriages, particularly at night, in spite of the increase in cost and the nuisance

of shunting these in the large stations en route. This is, indeed, a very effective way of keeping an important class of passenger for the railways; on the other hand, the question of through carriages by day needs to be weighed more carefully, as in this case through carriages are not absolutely essential except in the case of certain particularly important services, and even in this case the Company must be certain that the running of through carriages does not involve a loss of load over certain parts of the system run over by the corresponding expresses.

Finally, Railway Administrations operating an extensive system agree upon the advisability of giving the public sleeping car facilities on the fast and express night trains; certain countries, however, such as Portugal and Rumania, wish to limit the use of sleeping cars to 1st class passengers, whereas others, such as Sweden, Norway and Poland, think it desirable to have sleeping car accommodation for all classes of passengers.

In France, we think a just balance should be maintained by offering passengers :

a) 1st and 2nd class sleeping car berths (1st class being reserved for very important services, mostly international services);

b) 1st class *couchettes* (4 per compartment) and 2nd class *couchettes* (6 per compartment).

The rates for these have been arranged to prevent any competition with sleeping-car berths, in such a way that they make up for the loss of receipts due to the decrease in the number of seats available (2 per compartment in the case of 1st or 2nd class). In addition, care is taken to avoid running 2nd class sleeping cars and 1st class *couchettes* on the same service, as the price per kilometre is very similar.

Third classe *couchettes* are not under consideration, as the difference between 2nd and 3rd class fares is small (at the present time 30 % of the fare per kilometre 3rd class), 2nd class being considered in France as merely an improved form of 3rd class travel intended for the middle classes; moreover, there are 8 seats per compartment in both classes.

To conclude, we think it reasonable to base the main line services on these principles, which tend to reduce the operating costs by giving up the idea of « speed at all costs » whilst maintaining satisfactory services both by day and by night, between the important centres, which reconciles as far as is possible the necessity for reducing the deficit in the passenger receipts with the desire to fight road competition and even, in certain cases, air competition.

b) Secondary lines.

The secondary lines are usually run at a loss; in fact as the table on page 34/18 shows, the cost price of the through and stopping trains is generally high (in France 290 fr. per steam train kilometre), and to meet this it is necessary to have an average user of about 240 passengers per train; such a high user is extremely rare, and consequently the Railways must be very careful in organising their secondary line services.

— In *France* the secondary lines with average traffic are served by 2 or 3 shuttle services of stopping passenger trains by day; at the present time, some of these services are increased by adding passenger coaches to goods trains, but such trains are extremely slow, which makes it impossible to assure the connections at the end stations of the journey, and satisfy the requirements of the public. Consequently it has been decided to stop this practice as soon as possible, and not to have recourse to it in the future.

To reduce operating costs on such lines, the French National Railways propose :

1) to put new and lighter rolling

stock into service, the main characteristics of which will be described later on;

2) to replace a large part of the stopping trains by single class (3rd class) railcars, an important order for which is already in hand.

These railcars will be of the following types :

a) Powerful 600 H.P. railcars, seating 68 (2nd and 3rd class), which can haul 1 or 2 bogie trailers (70 seats), intended in principle to improve the services on difficult sections of line (gradients of more than 15 mm. [5/8 in.] per metre);

b) Railcars of average power (300 H.P.), seating 62, which can be coupled up in pairs, or on easy gradients can haul a bogie trailer (70 seats). These single class railcars (3rd class) will be used on most of the secondary lines where the gradients do not exceed 15 mm. (5/8 in.) per metre, on which the passenger traffic, though fairly important, does not warrant the use of steam trains; lines served in this way will have a shuttle service of 3 to 4 railcars, and if need be a single rake of steam stock which will be retained to carry express parcels traffic and the mail which could not have been forwarded by the special high-speed goods train.

Some of these 300 H.P. railcars can be transformed into 420 H.P. 2nd and 3rd class railcars by the use of supercharging; they can then be used for certain cross country services linking up important towns.

c) Light railcars, of 150 H.P., single class (3rd class), seating 48, intended for use on secondary lines with little traffic on which it seems advisable to maintain the railway services rather than hand over the traffic to a road service;

d) As an experiment, railcars of very small horsepower (60 to 80 H.P.) which consist of a light railcar of the « Billard » type, or motor buses the wheels of which have been adapted for railway use, seating 35, for services on lines where the traffic is extremely light.

Most European Railway Companies appear to have adopted similar principles. Thus, provision is made :

— in *Belgium*, for a minimum of 3 services daily, which are sometines covered by railcars seating 80 to 100;

— in *Italy*, *Norway* and *Portugal*, in principle, for 2 or 3 services daily, partly by using railcars seating 50 to 80;

— in *Poland*, for two services a day in each direction, for which purpose 220 H.P. railcars seating 60 will be used to some extent;

— in *Rumania*, for 1 to 4 daily shuttle services, partly by using coupled railcars of 120 H.P. or 150 H.P., seating 100 to 200.

On the other hand, in certain countries with electrified lines, there are more services on the secondary lines. For example :

— in *Sweden*, there are 4 to 6 shuttle services a day, making use of rail cars or autotrains of various sizes (60 to 140 seats);

— in *Switzerland*, there are 8 to 10 trains in each direction daily, making use of electric motor coaches, as all the lines have been electrified;

— in *Holland*, there is a fairly frequent service, making use of railcars seating from 60 to 70.

Finally, all the Railway Administrations who, from force of circumstances, have had to use goods trains for passenger services, have decided to give up this practice as soon as possible, owing to the drawbacks entailed.

Naturally, on secondary lines with heavy traffic, in particular those serving working class centres, the number of services in each direction is of greater importance; here again they must not be multiplied indefinitely, as although the user of the trains is relatively high in this case, the reduced

fares granted to employees, workmen and scholars amount to a great deal, as a rule, and consequently there is a risk of the service being run at a loss.

Most Railway Administrations have, as in France, put in hand an important programme for the construction of railcars :

— in *Belgium,* there are double or triple autotrains, of more than 600 H.P., without trailers, used on certain express services, as well as lighter railcars (300 H.P.) for the stopping services on the main and secondary lines; the use of 150 H.P. railcars seems to have been given up.

— in *Holland,* there are high power diesel railcars for the express services; these are 1 950 H.P. in the case of the 5 unit sets and 800 H.P. in the case of the triple sets. There are also ordinary diesel railcars of 300 H.P. for the stopping services. They appear to be in favour of using small capacity railcars on the secondary lines with little traffic;

— in *Norway,* there are railcars of from 370 to 400 H.P. which can pull one or two trailers, and 130 H.P. railcars for lines with very little traffic. There are also 3 unit autotrains of 1 250 H.P. for certain express services;

— in *Sweden,* where most of the important lines are electrified, they are in favour of using 150 H.P. railcars or autotrains on lines with very little traffic; these can haul a light 7 t. (6.889 Engl. tons) coach;

— in *Poland,* it is proposed to make use of high powered railcars on the main lines, with two or three trailers, as well as low power railcars (150 to 200 H.P.) of small capacity on certain secondary lines;

— in *Italy,* it is proposed to use 400 to 500 H.P. railcars with trailers for the express services, and 250 H.P. railcars which can be coupled together in twos, threes or even fours, for the stopping services on the main and secondary lines. No provision has been made for the use of lighter railcars (150 H.P.);

— In *Switzerland,* where all the lines are electrified, a light 56 t. (55.115 Engl. tons) locomotive has been built to make the hauling of light trains as economical as possible;

— in *Greece,* provision has been made for the future use of 350 and 400 H.P. railcars which can haul one trailer;

— in *Algeria,* there are 600 H.P. railcars, which can haul a light trailer. No provision has been made for low power railcars (150 H.P.);

— in *Portugal,* during the war small railcars were used, with a 60 H.P. producer gas engine (27 seats), and plans have been made for the construction of 137 and 274 H.P. diesel railcars.

Generally speaking, the Railway Administrations are not in favour of using low power railcars of small capacity, owing to the numerous drawbacks associated with these vehicles; they are in fact rather fragile in build, do not work the pedals when the wheels run over them, and so do not short-circuit the track circuits, and finally cannot cope with any increase in the number of passengers, which necessitates frequent replacement of the railcar services by steam trains.

To conclude, the general opinion seems to be that the most economical method of serving secondary lines, in addition to a rake of steam stock which will assure the express parcels traffic and the mail, is to run 2, 3, 4 or even more railcar services of variable power and capacity, according to the importance of the traffic.

c) Suburban lines.

On suburban lines the profit per passenger kilometre is particularly low (in France it was 0.38 per passenger-km in October 1946); consequently there can be no question of improving these services, and the only thing to do is to endeavour to give the public, particu-

larly exacting in the case of such services, a reasonable service whilst endeavouring to reduce the operating costs as much as possible.

— In *France*, on the electrified lines, and even on certain steam lines with heavy traffic, the suburban services are covered by sets of trains at regular intervals, each train of the set being specially arranged to serve a given zone; the interval between trains is generally 20 to 30 minutes at rush hours and 1 to 2 hours at slack periods. In addition, on the electrified lines, the trains consist of groups of 2 or 3 coaches which can be coupled up or uncoupled according to the traffic requirements.

This method seems to be used on all the railways operating lines of this sort; for example :

— in *Belgium*, between Brussels and Antwerp, an electrified line, there are sets of trains running at 30 minute intervals at the rush hours; this is also the case in the suburbs of Brussel on the « Chemins de fer Vicinaux » and on the «Electrobel »; the trains consist of 1 or 2 coaches according to traffic requirements;

— in *Holland*, the suburban trains run at 30 minute intervals, with two additional trains during each rush hour; the composition of the trains varies from 4 to 6 or even 10 coaches according to traffic requirements;

— in *Poland*, the Warsaw to Grodzisk line is served by electric trains at 20 minute intervals, the number of coaches varying from 1 to 3;

— in *Sweden*, the suburban train sets are run at 15, 20 or 30 minute intervals, according to traffic requirements;

— in *France* (Metro, Sceaux line), the train sets run at 15, 20, 30 or 60 minute intervals, according to the time of day, the composition varying from 2 to 4 special coaches.

Generally speaking, it would seem that all the Railway Administrations agree that suburban lines with heavy traffic should be electrified and operated by means of sets of trains at regular intervals, each train being used for the service of a given zone. This method would appear to assure the maximum convenience for the public, and also enables lines with heavy traffic to be operated rationally, and, it would appear, in the most economical manner.

It should be pointed out, in conclusion, that the French National Railways, in the suburbs of Paris, on steam operated lines, are making use of reversible rakes of large capacity; these rakes which consist of 8 coaches seating 742 with standing room for 809, make it possible to operate certain suburban lines with heavy traffic on the same principles as electric lines; they have proved to be of great service on the lines using them.

* * *

CHAPTER IV.

Lightening of passenger rolling stock.

It can be stated that as a general rule all the Railway Administrations, before the war, were making use of the increased power of steam and electric locomotives to improve the comfort and safety of passengers, without increasing to any appreciable extent the transport capacity : thus the fast trains of 1890 which were made up of 4-wheeled coaches contained approximately the same number of seats as the express trains of 1938 with all metal bogie coaches; yet whereas the weight of the former was 250 t. (246 Engl. tons) in the case of the latter it might be :

700 t. (689 Engl. tons) on lines with steam traction; and

850 t. (836 Engl. tons) on lines with electric traction.

At the same time the dead-weight per passenger which was only 340 kgr. (750 lb.) in 1890, on the French National Railways in 1938 had increased to :

— 500 kgr. (1 212 lb.) 3rd class;

— 700 kgr. (1 543 lb.) 2nd class;

— about 1 t. (0.984 Engl. t.) 1st class;

— more than 2 t. (1.868 Engl. tons) on sleeping cars.

This increase in the tare of carriages is due to :

— the introduction of corridor trains, which decreases the number of seats owing to the side corridor;

— the installation of water closet toilets at the ends of coaches;

— the improvements made to the heating and lighting of carriages, both of which increase the weight;

— the increase in the space available per passenger;

— on certain foreign railways, the installation of a system of « air conditioning », which weighs 2 t. (1.868 Engl. tons) per coach;

— the use of metal coaches, which has increased their weight by about 22 %; thus on the French National Railways the wooden C^{10} coaches which weighed 37 t. (36.415 Engl. tons) have been replaced by metal C^{9}, C^{10}, or C^{11} coaches weighing 45 t. (44.289 Engl. tons).

In brief, before the war the Railways were merrily progressing towards a 50 t. (49.210 Engl. tons) coach, without bothering about the considerably increased operating costs such heavy stock would entail (particularly as regards the maintenance of the track and traction costs), a policy which moreover had the serious drawback of decreasing the average speed of the main trains. As moreover the Railways were obliged :

— either to meet road motor competition,

— or to meet the requirements of business men,

— or for reasons of prestige,

to run a certain number of particularly fast services, they were forced to introduce a certain number of trains which ran at a high average speed but were of very small capacity, only seating 150 to 250 passengers, which led to an inflated passenger train mileage, as explained in the previous Chapter.

The position on the different Railways in 1938 from this point of view is summed up in the following table, which gives the average tonnage of a metal bogie main line coach :

	1st. & 2nd. class coaches.	*3rd. class coaches.*
	Tonnes.	*Tonnes.*
France	48	46
Algeria	41	40
Belgium	42.5	41.5
Denmark	38	38
Greece	43.4	40
Italy	42	42
Holland	46	46
Norway	*38*	*35*
Poland	45	43
Portugal	*40*	*28*
Sweden	54	48
Zwitzerland — International services	*40*	*37*
Zwitzerland — Internal services	*29*	*28*
Jugoslavia	45	*35 to 42*
Rumania	47	46

This table is very significant, and shows the excessive weights which had been reached in the construction of passenger rolling stock. However certain Railway Administrations had begun to appreciate the dangers of this policy and had started to put into service lighter rolling stock, as the figures underlined in the above table show. In the case of the French National Railways, in the years immediately before the war, the former Companies had begun to lighten their stock; for example on the Est and Nord Railways, the 41 t. (40.352 Engl. tons) BD and CD coaches were put into service, and on the Ouest, the 35 t. (34.447 Engl. tons) A^8 of A^3 B^5 coaches and the 37 t. (36.415 Engl. tons) C^8, C^9 or C^{10} coaches.

The European war, which led to the destruction of a great part of the passenger rolling stock, has put the lightening of this stock into the foreground at the present time. The rolling stock, which has been destroyed, must be replaced, and consequently many European Railways have large orders to place.

To give some idea of the importance of these orders, the following table sums up the actual situation regarding the passenger rolling stock on certain Railways which suffered more particularly during the war :

	1938		*1946*		*Coefficient of reduction in usable stock.*
	Theoretical stock.	*Usable stock.*	*Theoretical stock.*	*Usable stock.*	
French National Rys. .	29 700	25 800	23 800	13 700	47 %
Belgium	7 900	7 600	5 300	4 800	37 %
Italy	6 800	6 000	4 850	2 100	65 %
Poland	10 550	8 950	8 550	4 450	51 %
Rumania	3 600	2 850	2 700	1 750	38 %

The re-establishment of the passenger rolling stock will therefore involve great efforts on the part of these countries, spread over several years.

What are the new conditions therefore which will serve as a basis for this work ?

In *France,* on the main lines, the new coaches, built of light metals, in which the weight of all the accessories has been reduced, will have the following characteristics :

— the adoption for the framing of the frame and body of the tubular design forming a homogeneous monobloc;

— incorporation of the frame in the body and of the body in the roof;

— using a double framework throughout the upper body to minimise the effects of telescoping;

— general use of light metals for all parts which do not play any direct part in the strength of the framing;

— research, within limits of safety, of all technical measures likely to obtain the minimum weight.

The improvements and the reduction of the different members (frame, bogies, body, internal fittings and seats) will result in the tare weight of the C^{10} coaches being reduced from 37 to 32 t. (36.415 Engl. tons to 31.494 Engl. tons), i.e. a deadweight of 400 kgr. (882 lb.) per passenger, which is lower than that of the old wooden coaches, whilst giving a degree of safety at least equal to that of the old metal coaches and maintaining the present internal arrangement of the metal coaches (separate corridor and compartments), an arrangement which as confirmed by a recent refer-

endum on the subject, seems to be liked by the public and is the most practicable, especially in the case of night travel.

On secondary lines, where the old stock of carriages with wheels and axles was considerably reduced during the war, the French National Railways have perfected a design for a metal bogie coach of tubular construction with a tare of 29 t. (28.542 Engl. tons). These coaches will be of 2 types :

a) a coach BD with 2 passenger compartments (50 seats), 2 platforms and a luggage compartment.

b) a coach C with 3 passenger compartments (78 seats) and 2 platforms.

The stopping trains on secondary lines will in principle be made up of one BD and 2 C coaches of the above type, which thanks to their light weight will enable the trains to start away quickly and to have close timings. In addition, the internal arrangements will be such as to give these coaches an up-to-date and comfortable appearance.

Finally, the French National Railways are proceeding with the design of a new type of super-light coach, for which a bogie of a completely new type will be used, weighing only 4 350 kgr. (9 590 lb.), which will make it possible to reduce the total tare by one tonne (0.984 Engl. ton).

For the main line services :

— in *Belgium*, the Belgian National Railways propose to build coaches and electric rail motor coaches in light metals;

— in *Italy*, the State Railways have recently put into service 3rd class coaches of high resistance steel with a tare of 32 t. (31.494 Engl. tons);

— in *Denmark*, a lightweight coach with a tare of 28 t. (27.557 Engl. tons) has been put into service;

— in *Holland*, the construction of a light weight 3rd class coach is under consideration;

— in *Norway*, the construction of a light weight 3rd class coach with or without a van is under consideration;

— in *Poland*, 1 000 3rd class coaches of the metal C^{10} type with a tare of 38 t. (37.399 Engl. tons) are under construction;

— in *Portugal*, some « Budd » coaches have been put into service, made of rustless steel, the tare of which varies from 28 to 32 t. (27.557 Engl. tons to 31.494 Engl. tons);

— in *Rumania*, metal bogie coaches C^9 with a tare of 28.5 t. (28.049 Engl. tons) are in use;

— in *Sweden* suburban coaches have been put into service; made of welded steel, their weight is 31 t. (30.510 Engl. tons);

— in *Switzerland*, where the matter has been for a long time under consideration by the Federal Railways, metal coaches are in use on the interior service in which aluminium has been used for the doors and accessories, of the following types :

AB^4u with a central corridor, weighing 29 t. (28.542 Engl. tons), 42 seats;

B^4u with a central corridor, weighing 28 t. (27.557 Engl. tons), 48 seats;

BC^4a with a central corridor, weighing 28 t. (27.557 Engl. tons), 55 seats;

C^4u with a central corridor, weighing 28 t. (27.557 Engl. tons), 72 seats.

In the case of the services on secondary lines, the proposals of the European Railways seem to be less definite, however :

— in *Italy*, it is proposed to build some new 4-wheeled coaches with a tare of 21 t. (20.668 Engl. tons) having a central corridor;

— in *Norway*, 3rd class coaches have been put into service having a tare of 17 t. (16.731 Engl. tons) with a central corridor;

— in *Switzerland*, the Federal Railways have designed 8 wheeled Bc and C

coaches for lines with heavy gradients, with covered platforms at the ends and fittings in aluminium, with a tare of about 20 t. (19.684 Engl. tons); these have a central corridor and contain 56 or 64 seats.

To conclude, we are of the opinion that steps of this sort should be resolutely followed, and the Railways should definitely renounce the construction of coaches weighing more than 34 t. (33.463 Engl. tons) in the case of bogie corridor vehicles, obtaining the necessary reduction in weight by using light metals and making all possible savings in the use of materials.

Thanks to this policy, we shall decrease the traction costs whilst maintaining the same train capacity, make it unnecessary to double head the trains in many cases, and reduce the cost of upkeep of the track and structures.

* * *

CHAPTER V.

Spreading out peak passenger traffic.

All Railway Administrations have to meet a rush of passenger traffic during the three months of the summer (July, August and September), and before certain holidays (Easter, Whitsun, end July, 15th August, end September, Christmas and New Year), in addition to the normal services.

In France, this was encouraged by certain reduced fares that were formerly introduced which obliged the Railways to maintain certain reductions in favour of groups, excursions, pilgrimages, etc., during these rush periods.

In most European countries, the situation is similar; thus the Public Authorities grant :

— in *Belgium,* a reduction of 30 to 40 % for holidays with pay between April and October;

— in *Italy, Norway, Poland* and *Portugal,* similar benefits;

— in *Sweden,* reduced fares for the 12 days holiday with pay guaranteed to all employees, and even free tickets to certain holiday camps.

The result is that during the 5 summer months the passenger services not only have to be increased, which is to be expected, but in addition for each holiday, certain trains leaving on the most popular days of the week have to be doubled, tripled, quadrupled, and even sometimes quintupled, a phenomena which occurs more particularly at the end of July, beginning of August and for holiday on the 15th August which comes in the middle of the period of heavy summer traffic.

To meet such peak traffic properly necessitates an extremely large stock of coaches, part of which will only be used for these addition services and remain idle all the rest of the year; in addition much light mileage has to be run to get back the coaches to the despatching stations without delay, *usually empty.*

If such a situation could at a pinch and in spite of all its drawbacks be supported before the war, it can no longer be today owing to the loss of stock due to the war.

This reduction in the rolling stock is general; it has been shown in the previous chapter to what extent it has been reduced. All the Railway Administrations, at the present time, agree that they no longer have the necessary stock with which to meet heavy rush traffic. This is true not only of the countries devastated by the war but also of those which remained neutral; Sweden for example considers that her present rolling stock is hardly sufficient, and Switzerland declares that many passengers have to travel standing, as her stock is insufficient at rush periods.

To clarify the matter, in France we have endeavoured to ascertain under what financial conditions these rush periods were worked, in particular that of the 15th August; we found, as we had

expected, that the additional trains, run during these rush periods, did not pay even when well filled, but on the contrary were worked at a loss.

The following graph shows the train mileage for 1938 day by day :

The greatest rush periods was for 4 days around the Feast of the Assumption, and we calculated as exactly as possible the number of coaches required to carry the traffic; it was found that 450 coaches were practically never used apart from this period. Taking the average composition of a relief train as 10 coaches, the sinking fund charge of these coaches in the cost of the train kilometre at the peak has been calculated at 235 francs (1938) bringing the total cost of the express train-kilometre, when all the other items estimated at 22 francs per kilometre are added, to 257 francs at its greatest peak; when it is remembered that in 1938 the receipts per passenger kilometre were only 0.187 francs, even if the 800 seats in a 10 coach train were all filled (which taken all round is never the case), such a train would only earn 150 francs, and consequently there was a deficit of more than 100 francs per kilometre.

It is therefore essential, and this is a point upon which all the European Railway Administrations (except Norway) are agreed, to take steps to spread out rush periods of traffic and even suppress such extreme peak which, as the rush period of the 15th August, necessitates the use of rolling stock never used at other periods.

Measures, which will achieve this result, are of two kinds :

a) of a rating nature;

b) of a technical nature.

a) *Measures of a rating nature.*

In France we think that certain reduced fares normally granted to passengers should be suspended during holiday periods.

These are mainly the reduced fares granted to groups and in the case of holidays with pay; as well as those given to holders of return tickets, when these are reintroduced.

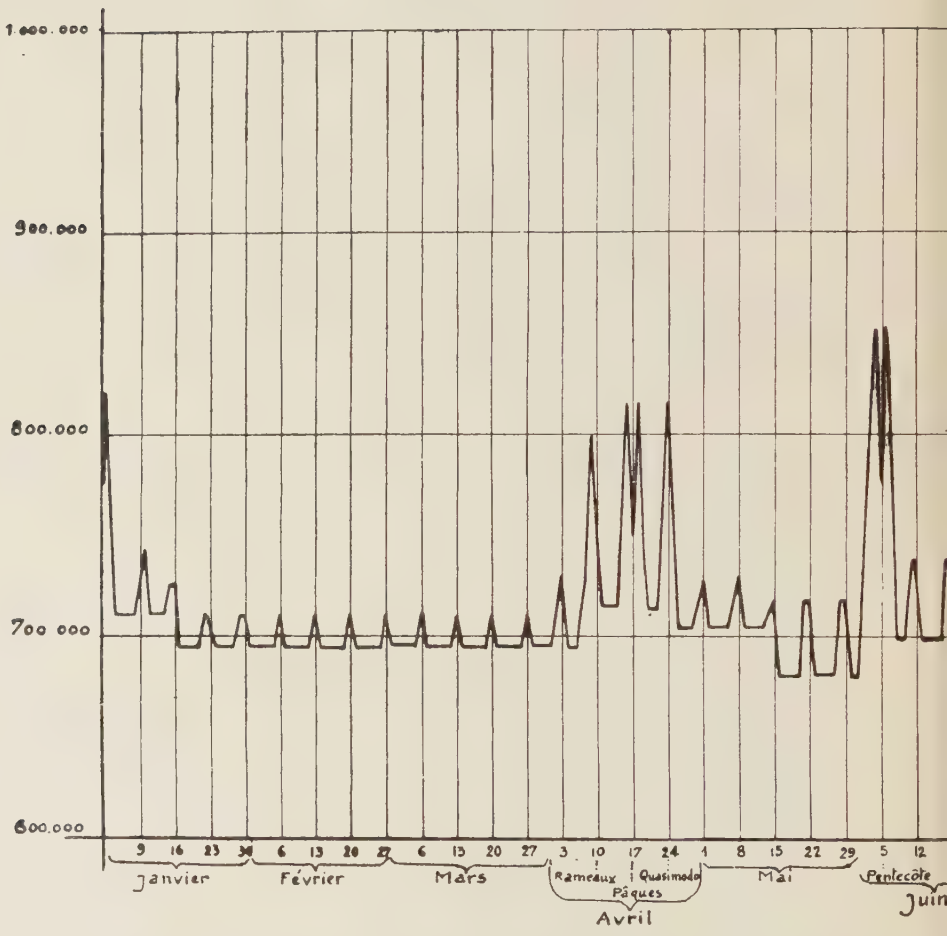
In other European countries, this does not appear to have been done up to the present; in *Belgium,* however, the reduced fares for holidays with pay are suspended between the 14th and 19th August, the 31st August and 1st September; in *Sweden,* the reduced fares granted to groups are suspended at rush periods; in *Jugoslavia,* all reduced fares are provisionally suspended.

b) *Measures of a technical nature.*

In France, the Management of the National Railways decided to limit the number of seats available at such periods; with this object in view, a programme is drawn up for double heading the express trains, avoiding as far as possible running light, whilst obtaining a rapid turn round of the stock; this programme is based on all the available coaches (including vehicles temporarily released from shops), taking into account the extent to which the stock can be used over again as well as the engine user for double heading. Once the programme has been fixed, the passengers are distributed over the different trains, even amongst those least in demand; this method of working has become relatively easy now that the public has got into the way of booking seats in advance since the war; moreover, during rush periods booking in advance is enforced in the case of certain heavily loaded trains, so that those who have not booked their seats are systematically diverted to other trains; in addition, without going so far as to make it necessary to book all seats, during rush periods, admission tickets are issued free for certain trains, the number being equal to the number of seats available plus 20 % for standing room.

This method of operating amounts in

(Actual da



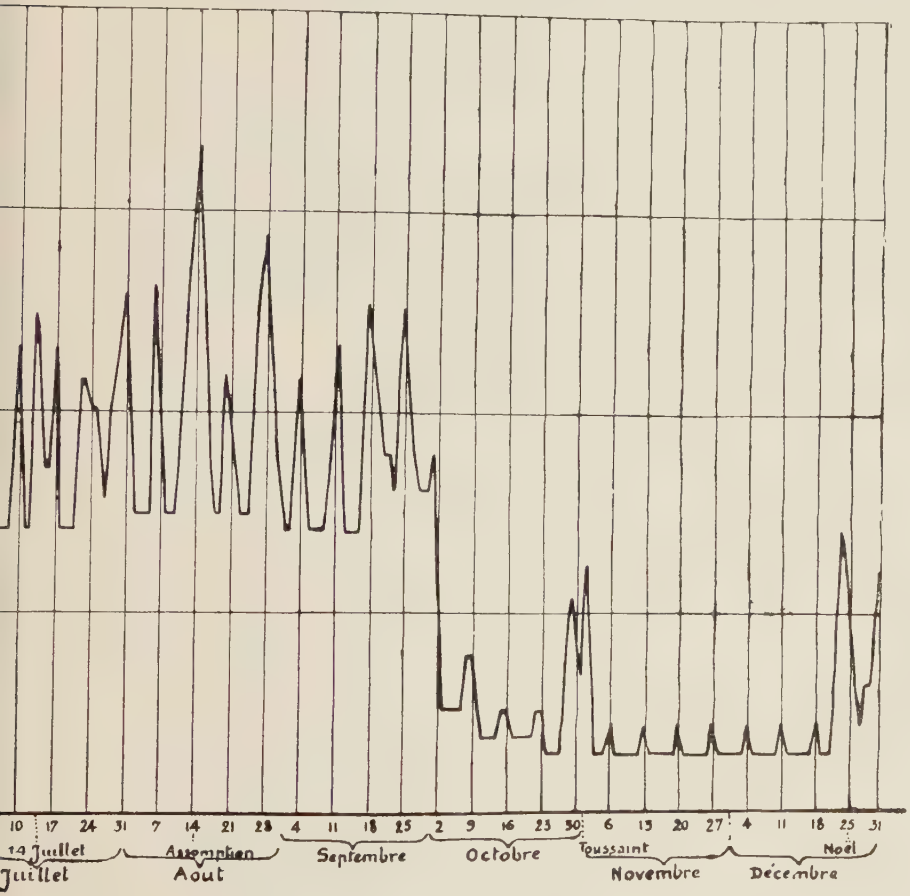
Explanation

Rameaux = Palm Sunday. — Pâques = Easter. — Quasimodo = Low Sunday. — Pentec

fact to « traffic control » during rush periods; to facilitate the application of this programme, all transport to holiday camps and pilgrimages are suspended during this period, and railway employees and their families cannot make use of their free passes at such times, either during the whole period or only on certain days and by certain trains. Finally, negociations have been entered into with Government Departments and the large factories of the Paris area to spread out their holidays with pay as much as possible, particularly with a view to ensuring that the days on which such holidays start will not coincide with the rush periods.

It does not appear that other Railway Administrations, in addition to the French National Railways, have resolu-

eage of passenger trains in 1938.)



terms :
tecost. — Assomption = Assumption. — Toussaint = All Saints. — Noël = Christmas.

tely undertaken similar measures. For example :

— the suspension of certain cheap fares is only practiced in Sweden;

— obligatory booking in advance for certain trains is only practiced in Norway, Sweden, Austria and Rumania;

— the application of a method of preliminary booking for certain trains is only practiced in Norway, Austria, Portugal and Rumania;

— the banning of certain trains to holders of cheap tickets at rush periods is practiced in Sweden, Holland and Belgium, only in the case of holidays with pay, and in Rumania for holders of cheap tickets;

— free travel for railway employees and their families is not allowed on cer-

tain trains in Sweden and Rumania only;

— the suspension of special pilgrimage and holiday camp trains during rush periods is only practiced in Italy, Poland and Austria.

However, generally speaking all the Railway Administrations draw up programmes in advance when it becomes necessary to double head the trains, to avoid running light, but in our opinion this measure, excellent in itself, runs a risk of being ineffective if nothing is done to reduce the public's desire to travel on certain days and by certain trains particularly in demand, and consequently the programme may have to be completely shelved.

We consider it essential from both the financial and technical points of view to take every possible step to spread out the traffic at rush periods, and even to suppress any extreme cases that may exist; moreover, for many years to come, the shortage of passenger rolling stock will oblige all the Railway Companies to work on these lines.

It may be objected that such measures would divert the traffic to road motor transport at holiday periods; very likely, but the answer is that even when things have returned to normal, there is bound to be competition between road and rail, and to endeavour to hold passenger traffic *at any price is nothing but a delusion.*

* * *

CONCLUSIONS.

Our enquiry amongst the different Railway Companies has brought to light the above measures intended to organise the passenger train services in such a way that they are operated at the lowest possible cost, whilst giving the public reasonable facilities.

In our opinion, the measures we have described should have been put into practice before the war in order to stop or at least diminish the growing deficit shown by all European passenger services. At the present time, such measures should be more rigorously enforced as the resources available to the Railways have been still further reduced. There is, however, no gain saying the fact that the public will demand a return to pre-war conditions, as though there had never been any war.

In our opinion, the demands which will be made, which will be supported in many cases by the Public Authorities, must be strenuously resisted; in the future the passenger services must never be organised in such a way that the goods rates have to be increased to maintain the general financial balance, as this would make the goods traffic particularly liable to competition from long distance road transport, which would result in *very serious losses* in the railway accounts as a whole.

To obtain the desired result it is necessary, in our opinion, for every Railway Administration to draw up a balance sheet for its passenger services, which will make the receipts and expenses belonging to these services quite obvious, so that they can consider how the former should be varied in terms of the latter, i.e. how the fares should be varied when the passenger train mileage varies. There is matter for a wide scale commercial investigation in this field, which might usefully form the subject of a special enquiry at a future Session of the International Railway Congress Association.

[625 .142]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

14th. SESSION (LUCERNE, 1947).

QUESTION I.

Sleepers :

a) different types;
b) maintenance methods;
c) financial comparison.

REPORT

(America, Great Britain, India, Dominions, Protectorates and Colonies, China and Egypt).

by J. C. L. TRAIN, M.C., M.I.C.E.,
Chief Engineer, London & North Eastern Railway.

A. General.

With a view to ascertaining the practice adopted by the various Railway Administrations, a questionnaire was submitted to the different Managements, but at the latest date for the submission of this report only twenty-four replies had been received out of a total of forty-five railways approached.

Owing to the restrictions on paper and printing it has not been possible to print the answer in full, but an analysis is given in the Appendices «A», «B» and «C».

The length of track covered by the report is 121 310 miles (195 229 km.), and this has been sub-divided as shown in Table 1, the classification of tracks being as follows :

Category 1. — Lines on which speeds are 60 miles per hour or over, or which carry trains weighing more than 1 000 tons.

Category 2. — Lines on which speeds are 40 to 60 miles per hour, or which carry trains weighing more then 500 tons.

Category 3. — Running Lines other than those included in Categories 1 and 2.

Category 4. — Sidings, i.e., not running line.

It will be observed that it has not been possible to summarise this table further, owing to the different forms in which some of the information has been supplied. It will, however, indicate the division of Categories and the user of the different types of sleeper.

PART A. — Different types.

It is, perhaps, surprising that no new material has been found to take the place of timber, steel, and concrete sleepers, the only alternative used being C.I. pots.

The continuous timber beams in use are mainly those over viaducts and on the underground railways.

The only examples of continuous concrete foundations and other designs not particularised in the Questionnaire are to be found on the London & North-Eastern Railway of Great Britain. Although these are only very short lengths, and are purely experimental, it is thought that the details given in answer to Question 45 and 46 may be interesting.

Conclusions.

Owing to local conditions and different practices arising therefrom, it is suggested that it is impossible to lay down any hard and fast rule in regard to either the size, the material, or the treatment of sleepers, but the following broad conclusions are put forward for discussion.

No reasonable alternative has been found to the cross tie or sleeper.

Wood is still the material preferred almost universally for sleepers.

Preservation process is applied to wood by only about one-third of the Railways who have been approached, and creosote or creosote and oil mixed is the most popular preservative. It is probably correct to say that as time goes on a greater proportion of the sleepers used are treated with preservative, but this cannot be established definitely from the replies given.

As regards sleeper spacing, it would seem that between 2 100 and 2 400 sleepers per mile is adequate where maximum axle loads are about 22-tons, but where, as in North America, the axle loads are about 50 % heavier, then it becomes necessary to use about an additional 1 000 sleepers per mile. It is not thought necessary by the great majority of railways to use any extra sleepers on curves.

It is thought that the length of a sleeper has a definite influence on the stability of the track, i.e., it should not be made too short. 8′6″ seems to be considered the minimum length which should be used with 4′8½″ gauge track.

The width of sleepers has also an influence on the stability both laterally and longitudinally, and dimensions which are most popular seem to be 9″ to 10″ wide, with a depth of 5″, but again in North America, because of the heavier axle loads the depth is more commonly 7″.

It is impossible to lay down anything in regard to the variety of timber which should be used for sleepers, because there is such variation necessitated by economic considerations. It is unusual to have felling restrictions.

There is only one Company which lays sleepers intentionally heart side up; it is almost standard practice to lay them the other way. It is suggested here that the life is about the same whichever way up sleepers are laid, and in deciding this question other considerations should be taken into account.

As regards specification, it is the general rule to allow limited wane on two edges and to strictly limit boxed hearts.

The great majority of Railways obtain their sleepers by contract.

It is usual to season sleepers in the air, and only in one case are drying kilns used. Seasoning periods vary according to climate, but it seems to be generally within the limits of three to twelve months.

Adzing and boring is carried out by Railway Compagnies' own forces in the majority of cases, and it is done by machinery.

From replies received it would appear that mechanical wear is the chief factor in destroying sleepers, but it is suggested that as stated by five Railway Companies decay is responsible where sleepers are not treated.

The preservative process has no effect on the electric resistivity of sleepers.

The majority of Railway Companies do not incise sleepers.

Preservation is carried out by Railway Companies in their own depots, where pressures and temperatures are recorded. It is not usual to carry out tests, except in some cases to use an increment borer immediately after treatment. Artificial tests are not resorted to.

The majority of Railway Companies use « S » irons for repairing split sleepers, although there are a surprising number who do not carry out this type of repair.

Systems of grading serviceable sleepers taken out of running lines are employed in almost all cases, but nothing standard can be laid down in this direction.

The most common fastening for attaching a rail to a sleeper with or without baseplates is the dog spike, but it would appear that spring spikes are becoming more popular.

All ballast is considered suitable for use with wooden sleepers. The majority of Railway Companies specify the type of ballast to be employed, although there are quite a number who do not.

It is general to use recovered sleepers for a number of railway purposes.

It is impossible to lay down any standard in regard to either shape or the sizes of steel sleepers which should be employed.

Hook bolts and clips would appear to be the usual method of fastening flat bottom rails to steel sleepers. It is the exception outside Great Britain to fix baseplates or chairs to steel sleepers. It is not considered that if bolts project through steel sleepers to the underside that undue wear takes place due to grit and water.

Corrosion followed by cracks around the baseplate or chair seat is responsible for the majority of failures of steel sleepers.

There is apparently no insulated steel sleeper which would permit it being used in track circuited territory.

There is a definite use for steel sleepers when finished with in the track in the majority of cases.

Only the British Railways report using pre-stressed concrete sleepers.

Tests of the reversal of stresses have been carried out by one British Railway, and the results are shortly to be published.

One Railway Company claims that concrete sleepers can be used successfully with track circuits, if the holes through the sleepers are sealed with bitumen.

It seems correct that large ballast should not be used with concrete sleepers.

The only use for old or recovered concrete sleepers is to use them for paving or flooring.

Only the London & North-Eastern Railway of Great Britain has got serious experiments in hand for employing concrete beam track.

PART B. — Maintenance methods.

The most popular form of packing is by hand beater, with shovel packing second, and machine packing third. This applies to both timber and steel sleepers. In the case of concrete sleepers no railway uses power tools.

Worn holes in timber sleepers are most commonly repaired with wooden plugs.

A limited amount of repairing of steel sleepers is carried out by welding in the track. No repairs to concrete sleepers are reported.

There is no conclusion as to where the top of the ballast should finish; this varies a very great deal.

Power driven adzing machines are used in a limited number of cases.

The period between re-boring for regauging purposes varies very greatly.

Outside Great Britain the most common method of sleeper renewal is to « spot » sleeper. In Great Britain it is the common practice to renew all sleepers at once.

PART C. — Financial comparison.

Part (c) of the Appendix giving financial particulars has been drafted in English money as a standard of comparison, in view of the fact that a large amount of the information was given in this currency.

Owing to geographical and other local conditions it will be noted that there is a great variation in the figures which again makes it almost impossible to lay down any hard and fast rule which could be applied in all countries.

In regard to the renewal of sleepers, practices vary in some countries, as in Great Britain it is customary to renew a whole length of sleepers, amounting perhaps to a mile or two at one time, whereas in other countries sleepers are renewed by a process of « spot » sleepering each year, so that it is understandable a very much larger percentage of serviceable sleepers is obtained under the first process described than in the second case.

It will be noted in the case of the British Railways that the percentage which are recovered varies between 40 and 70 % serviceable sleepers, and the additional life thereafter varies between 10 and 20 years. The result under normal conditions in South Africa approximates to this, also in New Zealand and Egypt, but in other cases the additional life given is so little as to be of practically no account from an economic point of view.

As regards the different materials, averages indicate the following :

40 % timber sleepers recovered;

45 % steel sleepers recovered;

5 % concrete sleepers recovered;

on completion of the first life, and the average additional life thereafter is as follows :

10 years timber sleepers;

14 years steel sleepers;

7 years concrete sleepers.

Despite the variation in figures, it would appear that treated timber sleepers with fastenings approximate to the cost of steel sleepers, and that concrete sleepers cost more than either timber or steel. It is obvious, therefore, that owing to the disadvantage of steel and concrete from a track circuiting point of view, timber sleepers are, as pointed out earlier, not likely to be superseded under present conditions by steel or concrete, i.e., so long as timber is available. It must not be overlooked, however, that if the cost of a sleeper per annum is examined, the concrete sleeper may be cheaper in the long run than any other type of sleeper, but this is based on a 50 years' life for a prestressed concrete sleeper, and there is not sufficient experience yet to say whe-

ther this estimate of life is likely to prove correct or not.

As regards the full cell process of creosoting this would appear to be the most common, but except in Great Britain it would not appear general to use pure creosote, the creosote in other cases being mixed with 50 % to 75 % fuel oil. A larger quantity of creosote per cubic foot of timber is employed in Great Britain than elsewhere, although some of the figures, particularly those for the American Railways, are so low that there is some doubt as to whether they are correct. The maximum impregnation represents one gallon per cubic foot in Great Britain when treating Baltic Redwood, and this quantity decreases to about two-thirds of a gallon per cubic foot maximum in the case of Douglas Fir. In the case of Maritime Pine and Scotch Fir this figure is reduced to ½ gallon per cubic foot.

The figures sent in are not sufficient to prove that the cost of creosoting is justified by the increased life so given, but it is suggested that there is no argument about this where softwood sleepers are concerned, i.e. creosoting is justified unless there are local supplies of white wood which can be laid in the track at low cost.

The cost of adzing and boring is given in one or two cases in Table 17, and as mentioned earlier in the Paper adzing may or may not be required according to whether the sleepers is laid sawn side up or sawn side down.

A very limited number of figures have been sent in in regard to the cost of packing or tamping sleepers, and there is a very great variation in those figures which have been supplied. It is probable that many of the figures cover different operations, for instance, some of the costs may include the cost of lifting as well as packing. It would seem fair, however, to make the following deduction. The cost of pneumatic or electric tamping of sleepers is less than the cost of hand beater packing of sleepers. This applies to examples given from the Argentine, U.S.A., and Great Britain. It would also seem fair to say that shovel packing costs less than pneumatic or electric tamping, and is therefore the cheapest way of putting a good top on the track at the time of the operation. On the other hand, the life of any form of packing must play an important part in the working out of financial cost, and in this connection it is suggested that track packed by means of power beaters stands up for longer than when packed by other means. One suggestion is that it lasts twice as long, but this is rather a matter for debate, and is not established by any figures given in the Paper.

APPENDIX A.

PART A.

1. — *What length of single track is equipped with sleepers or ties of :*

(a) Timber;

(b) Steel;

(c) Concrete;

(d) Other material (if any)?

ANSWER. — See Table 1.

2. — *What length of single track is equipped with other than cross sleepers or ties as follows :*

(a) Continuous timber beams or rail bearers;

(b) Continuous concrete foundation (other than on bridges and viaducts);

(c) Any other design of track not covered by above ?

ANSWER. — See Table 1.

3. — *(a) Give number of sleepers of each type kilometre or mile in modern renewals.*

(b) What is corresponding number of sleepers for rail length ?

(c) Give modern rail length referred to above.

(d) Are additional sleepers used on curves ?

(e) If so, what is limiting radius of curve ?

(f) What is the spacing of the sleepers at rail joints in modern practice ?

ANSWER. — See Table 2.

4. — *(a) Say if length of sleeper has influence on stability of track.*

(b) Say if length of sleeper has been determined in order to avoid splitting by insertion of fastenings.

ANSWER. — (*a*) Yes — 19 Railways; No. — 0 Railway; Doubtful — 5 Railways.

(*b*) Yes — 4 Railways; No. — 11 Railways; Partly — 5 Railways; Doubtful — 4 Railways.

5. — *Say if width of sleeper has any influence on stability of track :*

(a) Laterally.

(b) If so, give width of ballast shoulder on straight and curved track.

(c) Longitudinally.

(d) Say if wide sleeper is used at rail joints.

ANSWER. — (*a*) Yes — 17 Railways; No. — 3 Railways; Doubtful — 4 Railways.

ANSWER. — (*b*) :

Gauge of track.	*5'6"*	*4'8½"*	*3'6"*	*Metre.*
Max. width of Ballast Shoulder	30" (.76 m.)	39³/₈" (1 m.)	9" (.23 m.)	32" (.8 m.)
Min. width of Ballast Shoulder	11" (.28 m.)	6" (.15 m.)	6" (.15 m.)	9" (.23 m.)
Average width of Ballast Shoulder . . .	17½" (.44 m.)	17½" (.44 m.)	7½" (.19 m.)	17" (.43 m.)

(*c*) Yes — 12 Railways; No. — 2 Railways; Doubtful — 10 Railways.

(*d*) Yes — 6 Railways; No. — 18 Railways.

6. — *(a) What is total length of running lines measured in single tracks in each category ? (This should agree approximately with A 1 and 2 above.)*

(b) What is total length of sidings (excluding running lines) measured in single track ?

ANSWER. — See Table 1.

7. — *Give maximum loads of engines or vehicles operating on the lines in each of the Categories 1 to 4 referred to in the note under « A — General ». If possible give also minimum distance between axles where the axle carrying the maximum load is adjacent to another or others also carrying heavy loads.*

ANSWER. — See Table 3.

Timber sleepers.

8. — *What are the different varieties of timber you use or need for sleepers ?*

(a) Pre-war;

(b) During the war;

(c) Post war;

(d) Give approximate percentage of each variety mentioned above.

ANSWER. — See Table 4.

9. — *Say if possible what percentage of different varieties of timber were or are used with :*

(a) Flat Bottom rails;

(b) Bull Head rails.

ANSWER. — It has not been possible to answer this question in the manner originally intended owing to lack of information.

See Table 5.

10. — *Give gauge of track; if more than one, give percentage of each gauge to total length of track given in A 1 and 2.*

ANSWER. — See Table 1.

11. — *Are sleepers laid heart side up or heart side down.*

ANSWER.

Heart side down	19 railways.
Heart side up	1 railway.
Varies with timber used .	1 railway.
Without distinction . . .	2 railways.
Timber sleepers not used .	1 railway.

12. — *What are the dimensions of your sleepers :*

(a) Length (say if sawn to length or alternatively give permitted tolerance)?

(b) Width ?

(c) Depth (If different sizes are used, give each) ?

ANSWER. — See Table 6.

13. — *What is laid down in your specification in regard to shape, etc. of sleepers which will be accepted :*

(a) Wane ?

(b) Boxed hearts ?

(c) Other features ?

ANSWER. — See Table 6.

14. — *(a) Do you possess your own forests for the production of sleepers, or are these obtained by contract ?*

(b) From your own country ?

(c) By import ? (If so, are they in actual sizes or are they in « Blocks » to be sawn to size on receipt ?)

(d) From what countries do you obtain sleepers, give variety in each case ?

ANSWER. — (*a*) State forests, and by contract 2 Railways; By Contract 21 Railways; Steel sleepers only 1 Railway.

(*b*) 13 Railways; 7 Railways use both own country's and imported (in actual sizes). 1 Railway uses only steel sleepers.

(*c*) 3 Railways import sleeper in actual sizes.

(*d*) See Table 4.

15. — *How are the sleepers made ?*

(a) In portable sawmills ?

(b) In stationary sawmills ?

ANSWER. — (*a*) & (*b*) Stationary sawmills 8 Railways; Both portable and stationary 7 Railways; By hand 6 Railways; Do not know 2 Railways; Steel sleepers only 1 Railway.

16. — *Are you restricted in regard to the variety of timber you may use for sleepers, in other words, is there a restriction on the felling of certain species of tree, or as to the season of the year in which the trees are felled ?*

ANSWER. — See Table 7.

17. — *Do you season the sleepers ?*

(a) In the air (natural seasoning) ?

(b) In water ?

(c) Artificial seasoning or drying methods ?

ANSWER. — See Table 7.

18. — *What is the duration of seasoning before being used in the track or before being put through the preservation process for different varieties of timber given in A. 8 above and for the different methods of seasoning ?*

ANSWER. — See Table 7.

19. — *(a) Are sleepers bored and/or adzed by hand or by machinery ?*

(b) Is adzing and boring done by your own forces, or is it done by contract ?

ANSWER. — See Table 7.

20. — *(a) Do you use a process for preserving sleepers, or do you put them in the track without this ?*

(b) What process do you employ ? (Give details of process, e.g. pressures, duration, draining, etc.)

(c) If creosoting say whether empty or full cell process.

(d) If possible give specification for creosote or salt used, giving strength of solution if other than creosote.

(e) State what quantity of preservative is absorbed for each variety of timber treated and for each process.

ANSWER. — See Table 8.

21. — *State usual cause of ultimate failure in the case of each variety of sleeper, i.e. is it mechanical wear, splitting or decay in the case of :*

(a) White or untreated sleepers;

(b) Sleepers treated with preservative.

ANSWER. — *(a)*

Decay . . . . . 5 Railways.
Mechanical and decay . . 2 Railways.
Mechanical wear, spike killed, and splitting . . 11 Railways.
Not used . . . . . 6 Railways.

No varieties are specified, except for two cases of mechanical wear, in which Jarah is named.

(b)

Mechanical wear, splitting and decay . . . . . 9 Railways.
Mechanical wear . . . . 3 Railways.
Dry rot . . . . . 1 Railway.
Not used . . . . . 11 Railways.

The 5 British Railways report decay and mechanical wear for Baltic Redwood, and splitting and decay in the case of Douglas Fir.

22. — *What difference in treatment did the war necessitate ? If any difference describe the treatment.*

ANSWER. — The 5 British railways used creosote of a lower standard and limited the timber seasoning period. One of these railways also used Wolman Salts as an alternative to creosoting.

The Sudan Government Railway added 75 % fuel oil to the creosote.

17 other railways made no alternation.

1 railway uses only steel sleepers.

23. — *State what is the influence of the preservative process used on the electric resistivity of the sleepers.*

ANSWER.

None . . . . . 3 Railways.
Not known . . . . . 20 Railways.
Only steel sleepers used . 1 Railway.

24. — *Are sleepers incised ?*
If so, state in the case of what timber this practice is adopted.

ANSWER.

5 railways incise Douglas Fir.
1 railway incises Deodar, Fir and Kail.
2 railways incise all sleepers.
15 railways do not incise sleepers.
1 railway uses only steel sleepers.

25. — *(a) Is the preservation or impregnation of sleepers done in Railway depots or by contract ?*

(b) Do you have gauges to record pressures and temperatures when sleepers are being treated ?

(c) What laboratory or other tests are carried out before the sleepers are put into the track, if any, to determine the amount of impregnation accomplished ?

(d) Are any artificial tests carried out to determine the behaviour and probable life of sleepers when they are in the track ?

ANSWER. — (*a*)

In railway depots. . . .	4 railways.
In railway depots in the past, not now done . .	1 railway.
By contract	4 railways.
Both	2 railways.
No process used	12 railways.
Only steel sleepers used .	1 railway.

(*b*)

Yes	9 railways.
No	None.
No process used	13 railways.
Uncertain — done by contract	1 railway.
Only steel sleepers used .	1 railway.

(*c*) The only checks made are as follows :

(1) Amount of preservative used per batch;

(2) A number are bored with increment borer immediately after treatment to determine the depth and distribution of preservative;

(3) Sample weighing.

(*d*)

No	12 railways.
Preservative not used . .	11 railways.
Only steel sleepers used .	1 railway.

26. — *What methods, if any, are employed to repair sleepers which have split ?*

ANSWER. — 11 Railways use steel end clamps, S iron screw dowels and bolts.

4 Railways use Hoop iron bands.

8 Railways do not use any type.

1 Railway uses only steel sleepers.

27. — *Do you have a system of grading sleepers when taking them out of the main line ?*

(b) If so, state what grades there are, and the conditions which determine the various grades.

(e) What grade of sleepers is used in lines under Category 1 ?

(d) What grade of sleepers is used in lines under Category 2 ?

(c) What grade of sleepers is used in lines under Category 3 ?

(f) What grade of sleepers is used in Sidings (Category 4) ?

ANSWER. — See Table 9.

28. — *(a) What types of rail do you use with timber sleepers ?*

(b) Is the rail attached direct to the sleeper or do you use tie plates, baseplates or chairs ?

(c) If you use different methods of attaching the rail to sleepers, give approximate percentage of each type of fastening.

(d) Do you use through bolts ? If so, give diameter and diameter of borings in sleepers.

(e) If so, do you have to employ insulation with track circuits ?

(f) Do you use coach screws ?

(g) If so give diameter, length and diameter of boring in sleeper.

(h) Do you use ordinary dog spikes or spring spikes ?

(j) If so, give size and diameter of borings in sleepers.

(k) If the rail is laid direct on the sleepers without a baseplate, is it held

in position laterally by the adzing in addition to the spikes, or do you have another device ?

ANSWER. — See Table 10.

29. — *Give present weight or weights of rails used in the lines included in each of the categories referred to in the note under « A — General ».*

ANSWER. — See Table 5.

30. — *(a) Is there any type of ballast which cannot be used by you with timber sleepers ?*

(b) Give standard depth of ballast under track in fast passenger lines.

(c) Do you specify any particular type of ballast for track circuited track with wood sleepers ?

(d) Have you any use for timber sleepers in lines of each category when they are not fit for further use in the track ?

ANSWER. — (*a*) All railways agree that all material suitable as ballast can be used with wooden sleepers.

(*b*) Minimum depth 6″.
Maximum depth 12″.
Average depth 10″.

(*c*) 11 Railways do not specify any particular ballast.

13 Railways specify (or express a preference) for stone, slag, gravel and granite.

(*d*) Fencing and walling, paving, cribbing, bases for posts, petty structural works and firewood.

Steel sleepers.

31. — *(a) Give dimensions of various types of steel sleepers.*

(b) Give shape, both longitudinal and transverse, i.e. flat, T *— shaped, or channel section, with flanges up or down as shown in sketches.*

1. 2. 3. 4.

(c) Give weight of various types of steel sleepers and say if these include weights of baseplates or chairs.

(d) Give proportion of the various steel types used.

ANSWER. — See Table 11.

32. — *How are rails fixed to steel sleepers, i.e. :*

(a) Are they attached direct to the steel sleeper by bolts ?

If so, give diameter of bolts and diameter of drillings in sleepers.

(b) Is a baseplate or chair welded on or otherwise fixed to the sleepers ?

(c) Is the rail fastening an integral part of the steel sleeper ?

(d) If bolts are used do they touch the ballast on the underside ?

(e) If bolts rest in the ballast on the underside do the sleepers suffer from wear due to grit and water getting through the bolt holes ?

ANSWER. — See Table 11.

33. — *Say how steel sleepers ultimately fail in service.*

ANSWER. — The causes of failure are stated by nearly all users as follows:

Cracks round rail or chair seat.
Corrosion.
Jaws springing open in pressed up lug type.
Bending.

34. — *Are steel sleepers used in tracks equipped with track circuits and if so, how are they insulated ?*

ANSWER. — No case of steel sleepers used on track circuited track is reported.

35. — *(a) Is there any type of ballast which cannot be used by you with steel sleepers ?*

(b) Do you specify any particular type of ballast for track circuited track with steel sleepers ?

ANSWER. — (*a*)

Large ballast is considered unsuitable (6 railways).

Ashes, clinker and earth containing corosive salts unsuitable (3 railways).

Sand is not favoured (2 railways).

No type considered unsuitable (9 railways).

(*b*) No case of steel sleepers used on track circuited track is reported.

36. — *Say if possible what percentage of steel sleepers are used with :*

(a) Flat bottom rails.

(b) Bull headed rails.

ANSWER. — See Table 11. The percentages shown in the last two columns of this table refer to the percentage of all steel sleepers used and not to all types of sleepers.

37. — *Have you any use for steel sleepers in lines of each category when they are not fit for further use in the track ?*

ANSWER. — Six railways report the use of old steel sleepers for fences, walls, and revetment of ditches. Two other lines hammer them flat and use them for secondary blacksmith's work.

One railway uses a flat bottom rail type sleeper with bull head rail held in a C.1. chair fitted between the lugs in the rail seat.

Eight other lines report no further use when finished in the track.

Concrete sleepers.

38. — *(a) Do you use plain concrete ?*

(b) Or are they reinforced ?

(c) Give dimensions of concrete sleepers used.

(d) Give weights of concrete sleepers used.

(e) Do you use pre-stressed concrete sleepers ?

(f) Do you manufacture concrete sleepers or are they obtained from contractors ?

(g) Give proportion of the various types of concrete sleepers used.

(h) Do you use concrete sleeper blocks ?

(I) *Plain*

(II) *or reinforced.*

(j) If so, do you use a connecting bar between the blocks ?

(k) If no connecting bar is used, at what intervals of distance do you interpose through sleepers to preserve gauge ?

(l) Give dimensions of blocks.

(m) Give weight of blocks (include weight of chair or baseplate where these are cast on).

ANSWER. — See Table 12.

39. — *(a) What type of rail do you use with concrete sleepers ? If more than one type, give proportions of each to the total tracks having concrete sleepers.*

(b) Describe how rails are attached to concrete sleepers or blocks.

ANSWER. — See Table 12.

40. — *Have you been able to use concrete sleepers in tracks equipped with track circuits ?*

(b) If so, give details of insulation arrangements (if any).

ANSWER. — (*a*) & (*b*) The South Indian Railway is the only one reporting the use of concrete sleepers on track circuited track. No part of the metallic fixtures is nearer to the bottom of the block than $\frac{1}{2}''$. All recesses into which bolts are fixed are plugged at the bottom

with bitumen filling of minimum depth ½" and flush with bottom of sleeper. Other Railways either do not use concrete sleepers, or have not tried to use them for this purpose.

41. — *Do you place concrete sleepers in the track by hand, or have you to use mechanical methods ?*

ANSWER. — Seven Railways lay the concrete sleepers in by hand. The London & North-Eastern Railway pre-assemble 30 ft. lengths of track on wagons, using old rails. These lengths are then laid in by crane and the old rails removed. The final track rail is then run in.

Sixteen railways do not use concrete sleepers or blocks.

42. — *State nature of ultimate failure of concrete sleepers in service.*

ANSWER. — Four railways report that no failures have so far been experienced with pre-stressed concrete sleepers, but these have not been in use for any great length of time.

Six railways (including the above four) say that normally reinforced sleepers fail through cracking, with ultimate exposure of the reinforcement.

Other railways either do not use concrete sleepers or have not yet sufficient information to reply.

43. — *(a) Is there any type of ballast which cannot be used by you with concrete sleepers ?*

(b) Do you specify any particular type of ballast for track circuited track with concrete sleepers ?

ANSWER. — (*a*) Four railways report that large ballast is unsuitable owing to the high local stresses it is likely to set up.

Four other railways state that there is no type of ballast which they find unsuitable.

Sixteen railways do not use concrete sleepers.

(*b*) The South Indian Railway, as only user of concrete sleepers on track circuited track specify granite stone ballast.

44. — *Have you any use for concrete sleepers in lines of each category when they are not fit for further use in the track ?*

ANSWER. — The North-Western (India) Railway use old concrete sleepers for flooring for stacked material and protection work for bridges. The only other use reported is as rubble.

Continuous beam track (i.e. other than with cross sleepers).

45. — *(a) Is continuous beam track constructed of any material other than concrete or timber ? If so, give details.*

(b) Say whether timber or other material (e.g. rubber) is interposed between the rail and the concrete or timber beam.

(c) Give method of fastening rail to concrete or timber beam.

(d) Have you any experience of how track constructed of concrete or timber beams founded on concrete or other materials affects track circuits ?

(e) What provision is made for drainage of space between beams ?

ANSWER. — (*a*) The only reported example of continuous beam track constructed of material other than concrete or timber is an experimental length of combined section steel beam track laid on the London & North-Eastern Railway.

The object of the experiment is to develop a type of track requiring the minimum of maintenance and inspection, especially in tunnels.

The « combined section » track consists of a mild steel channel 12″ × 3¹¹/₁₆″ and 75 lb. F.B. rail continuously welded on both sides of the rail foot. Gauge is maintained by a 3″ × 3″ angle tie at 3′0″ centres bolted to plates welded on to the combined section. (See figure No. 1.)

At joints, the rail and channel (comprising a unit of the combined section track) overlap by 1′0″ and the rail of a unit is attached to the channel of the adjacent unit by means of hook bolts and clips. Adjacent units are thus kept in line.

A short length of 24 lin. yards was laid 2¼ years ago in a slow passenger line on ordinary stone ballast. No special drainage measures were required on the site chosen.

Maintenance has been satisfactory, but there are indications that the welding of the rail to the beam is commencing to fail. As a result of the experience now available, improvements to details and to the foundation could be made, and will be incorporated in any future design.

(*b*) The only reported case of cushioning material being used between the rail and longitudinal beam is on the London & North-Eastern Railway, concrete beam track where elm packings are to be used under part of the track.

Rubber packing was used on a length of concrete beam track which has now been removed from the road owing to the concrete being of inferior quality.

(*c*) Flat bottom rails are fastened to the concrete beam track referred to in Question 46 by means of bolts and clips.

Bull head rails are keyed in chairs which are fastened to timber beam track by coach screws.

(*d*) The Southern Railway (Great Britain) report that track circuits are satisfactory on timber beam track founded on concrete, but it is not thought that concrete beam track will permit of track circuits being used.

(*e*) The London & North-Eastern Railway (Great Britain) concrete beam track referred to in 45 (*b*) will be drained by means of a tarmac invert between the beams, the water being carried away through pipes to the side drains. On tube line track the Southern Railway use a concrete invert in the four foot way filled with ballast, the water again being led away through pipes.

46. — *Describe method of constructing continuous concrete beam track.*

(a) Is it cast in situ ?

(b) Are concrete beams cast beforehand ?

(c) Is concrete in beams prestressed ?

(d) Are concrete or timber beams placed on a concrete foundation or on ballast direct or on other material ?

(e) If concrete or other material give dimensions of foundation and size of beam.

(f) How long is the concrete foundation given to set before traffic passes over the track ?

(g) In continuous beam track of concrete, timber or other material, is gauge maintained by tie bars ? If not, give method.

(h) Has any difficulty been experienced in maintaining top and line of continuous beam track ?

ANSWER. — The only experiment in continuous concrete beam track is reported by the London & North-Eastern Railway as follows :

The object of the experiment is to develop a type of track requiring the minimum of maintenance and inspection especially in tunnels.

The concrete beams, weighing 31 cwt. each, are 15 ft. long × 11 in. deep with a 2 ft. base, and have 457 lb. of steel reinforcement. Gauge is maintained by a 3″ × 3″ angle tie at 7′6″ c/c bolted to angles cast into the concrete (the

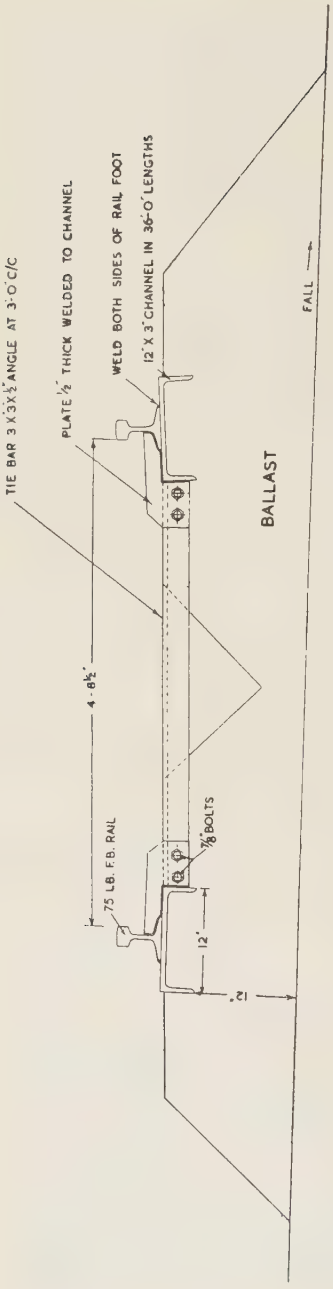

TIE BAR 3 X 3 X ½ ANGLE AT 3-0 C/C
PLATE ½ THICK WELDED TO CHANNEL
WELD BOTH SIDES OF RAIL FOOT
12 X 3 CHANNEL IN 36-0 LENGTHS
4 - 8½
75 LB. F.B. RAIL
⅞ BOLTS
12
BALLAST
FALL

Figure 1. — Combined section steel beam track.

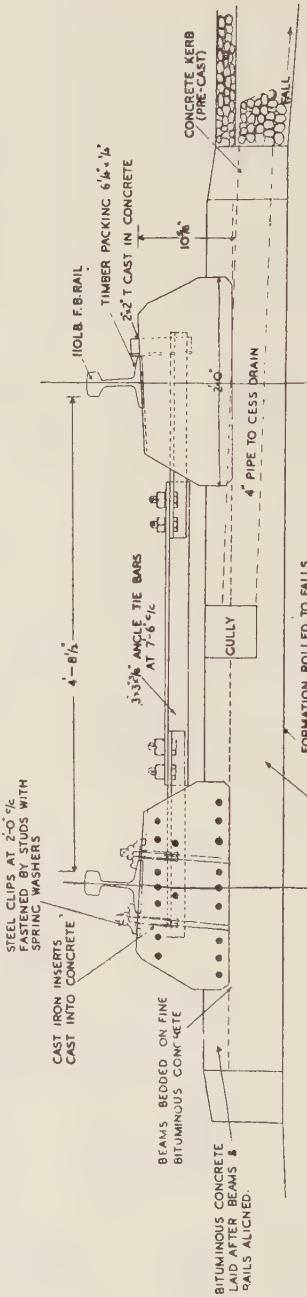

110LB F.B. RAIL
TIMBER PACKING 6¼ - ½
2½ T CAST IN CONCRETE
CONCRETE KERB (PRE-CAST)
FALL
4 PIPE TO CESS DRAIN
CULLY
3-3-⅜ ANGLE TIE BARS AT 7-6 C/C
4 - 8½
STEEL CLIPS AT 2-0 C/C FASTENED BY STUDS WITH SPRING WASHERS
CAST IRON INSERTS CAST INTO CONCRETE
BEAMS BEDDED ON FINE BITUMINOUS CONCRETE
BITUMINOUS CONCRETE LAID AFTER BEAMS & RAILS ALIGNED.
FORMATION ROLLED TO FALLS
BITUMINOUS CONCRETE 6 THICK UNDER BEAMS

Figure 2. — Concrete beam on bituminous concrete foundation.

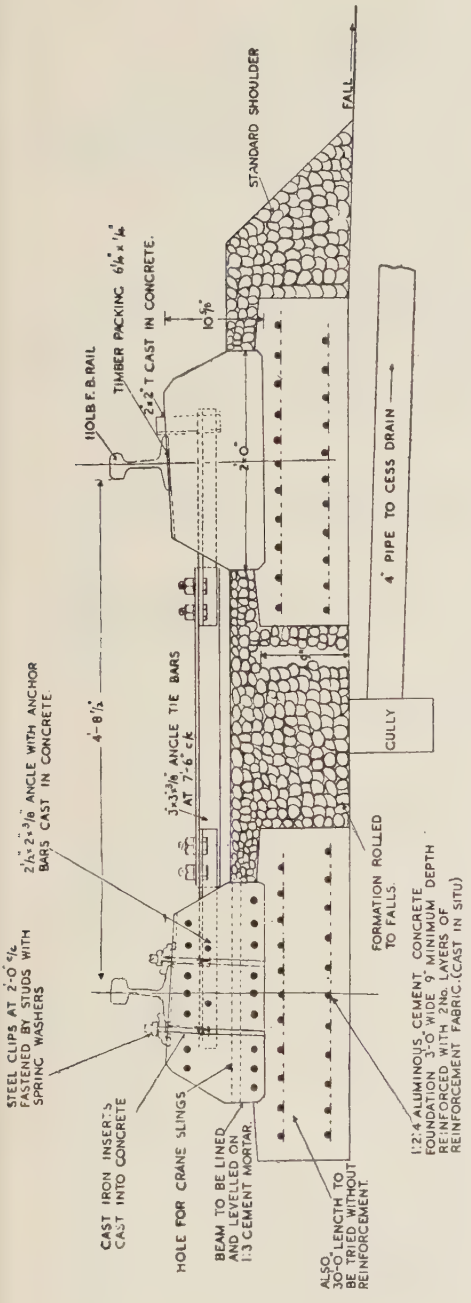

STANDARD SHOULDER
FALL
HOLE F.B. RAIL
TIMBER PACKING 6"x 1"
2"x2" T CAST IN CONCRETE.
10"
2'-0"
4" PIPE TO CESS DRAIN
3'-3"x 3/8" ANGLE TIE BARS AT 7'-6" c/c
2½"x 2"x 3/8" ANGLE WITH ANCHOR BARS CAST IN CONCRETE
4'-8½"
CULLY
FORMATION ROLLED TO FALLS
STEEL CLIPS AT 2'-0" c/c FASTENED BY STUDS WITH SPRING WASHERS
CAST IRON INSERTS CAST INTO CONCRETE
HOLE FOR CRANE SLINGS
BEAM TO BE LINED AND LEVELLED ON 1:3 CEMENT MORTAR
ALSO 30'-0" LENGTH TO BE TRIED WITHOUT REINFORCEMENT
1:2:4 ALUMINOUS CEMENT CONCRETE FOUNDATION 3'-0" WIDE 9" MINIMUM DEPTH REINFORCED WITH 2 No. LAYERS OF REINFORCEMENT FABRIC. (CAST IN SITU)

Figure 3. — Pre-cast concrete beam on concrete foundation.

latter are secured by « anchor bars »). The 110 F.B. rail is fastened by means of a simple clip and mushroom headed bolts, which screw into cast iron inserts cast into the concrete. A timber or rubber cushion is provided under the rail and spring washers are used at all connections.

The beams are to be laid on two types of foundation :

(1) A 6″ bituminous concrete raft 9 ft. wide, laid on the rolled formation. The beams will be bedded on a finer material and ballasted to the underside of the tie bars. *(See Fig. 2.)*

(2) Two 9″ × 3′0″ strips of reinforced aluminous cement concrete — the beams being bedded on aluminous cement mortar and ballasted as above. *(See Fig. 3.)*

On both types of foundation the space between the beams will be drained.

No provision will be made for adjusting line or level once the beams have been laid, but type (1) can be repaired if necessary and will be kept waterproof.

A length of 95 yards to the latest designs as described above is ready to be laid in in December 1946.

(*a*) No.

(*b*) Yes.

(*c*) No.

(*d*) Two types of foundation are being tried out. (1) On concrete; (2) On bituminised macadam.

(*e*) Foundation 3′0″ wide × 9″ deep and beam 2′0″ wide × 10″ deep.

(*f*) Within 24 hours.

(*g*) Steel tie bars are used.

(*h*) No difficulty has been experienced in maintaining the top line of steel beam track (See under No. 45). It is essential that stopped ends should be

provided to the trough to retain the ballast when packing is carried out near the ends.

The Southern Railway of Great Britain report that continuous timber beams on concrete foundations are used in tube line track as follows :

(*d*) Timber beams on concrete.

(*e*) 16″ × 16″ timber beams on concrete shelf (maximum depth 7″) resting on cast iron, tunnels invert.

(*f*) No record.

(*g*) Gauge is maintained by 7″ × 5″ transomes and 1″ diam. tie bolts.

(*h*) No difficulty in maintaining top and line has been experienced.

APPENDIX B.

B. — Maintenance methods employed with different types of sleepers.

Note. — Say what effect each method of packing or repair has on the life of the different types of sleepers.

1. — *With timber sleepers do you :*

(a) Pack or tamp with handbeaters ?

(b) Pack or tamp with pneumatic or electric beaters ?

(c) Shovel pack ?

(d) If so, to what extent is measured packing done ?

(e) Between what limit in the length of the sleeper do you pack ?

ANSWER. — See Table 13.

2. — *With steel sleepers do you :*

(a) Pack or tamp with handbeaters ?

(b) Pack or tamp with pneumatic or electric beaters ?

(c) Shovel pack ?

ANSWER. — (*a*) Eighteen railways use handbeaters for packing and tamping steel sleepers.

(*b*) One railway is experimenting with power tamping with steel sleepers.

(*c*) Seven railways shovel pack this type of sleeper.

3. — *With concrete sleepers do you :*

(a) Pack or tamp with handbeaters ?

(b) Pack or tamp with pneumatic or electric beaters ?

(c) Shovel pack ?

ANSWER. — (*a*) Four railways use handbeaters for packing and tamping concrete sleepers.

(*b*) No railway uses power tools with these sleepers.

(*c*) Four railways shovel pack this type.

4. — *If continuous beams are placed direct on the ballast, how are they packed ?*

ANSWER. — The only track applicable to this question is the L. & N. E. R. combined section steel beam track mentioned in Question 45. This length is shovel packed.

5. — *(a) At what intervals of time does the packing described above have to be carried out ?*

(b) To what extent is a method of packing governed by types of formation ?

ANSWER. — See Table 13.

6. — *(a) How do you make good worn holes in timber sleepers, i.e. do you use wooden plugs or some other process ?*

(b) Describe the other process if any.

(c) Do you have to repair steel sleepers in the track ? If so, describe method.

(d) Do you have to repair concrete sleepers in the track ? If so, describe method.

ANSWER. — (*a*) 23 Railways report the use of wooden plugs for this purpose. In some cases the sleepers are then pushed through the track for reboring. In one case the plugs are tarred before insertion and then cut off flush with top and bottom of the sleeper. One of the railways inserts a hollow trenail and then drives a round spike into it.

(*b*) 5 Railways have used an asbestos compound which is rammed tightly into the holes and the fastening screwed in whilst the compound is still plastic.

2 other railways use steel liners for insertion in conjunction with the dog-spikes.

(*c*) 5 Railways have done a limited amount of welding for repairing steel sleepers near the chair seat where cracking has taken place.

(*d*) No repairs to concrete sleepers have been reported.

7. — *Is the top of ballast level with or below top of sleepers of each type ?*

ANSWER. — See Table 13.

8. — *(a) Do you use portable adzing machines ?*

(b) Give names and description of adzing machines.

(c) At what intervals of time do they have to be used ?

ANSWER. — (*a*) Boring and adzing appears to mainly carried out in the central depots. 3 railways report portable machines.

(*b*) Nordberg Gasoline Power Adzing Machine.

Pickles auto feed boring & adzing machine.

Thos. Robinson & Co. Rochdale. Combined adzer & borer.

(*c*) 4 railways report that the sleepers are adzed and bored only when first laid in.

9. — *(a) Do you use portable boring machines for re-fixing the spikes, coach screws or through bolts ?*

(b) Give description of portable boring machines employed.

(c) At what intervals of time have sleepers to be re-bored in the track for re-gauging purposes ?

ANSWER. — (*a*) & (*b*) 4 railways use John Bull petrol engine boring machines where the quantity to be dealt with justifies it. The same railways also use petrol driven generators with electric tools.

1 railway uses Little Giant borers model $1\frac{1}{2}$ D & 3 D.

1 railway uses Miller Falls machines.

1 railway uses a gasoline driven power borer.

(*c*) 13 railways state that the interval of time depends entirely on the nature of the timber, the traffic and various other factors. The period varies from 3 to 15 years.

3 railways do not practise reboring.

10. — *To what extent do you « spot » sleeper as compared with complete renewal ?*

ANSWER. — See Table 13.

11. — *Do you employ any method of repairing cracked sleepers in the track apart from the new sleepers repaired at the depot in accordance with A. 26 above ?*

ANSWER. — 5 railways repair sleepers in the track and use end clamps, dog spikes and screws dowels.

APPENDIX C.

C. — Financial comparison.

The rates of exchange used in this comparison are as below :

	Equal to one English pound (£1.).
Argentine.	
Buenos Ayres Great Southern Railway	16.40 paper pesos
Beunos Ayres & Pacific Railway	Do.
Buenos Ayres Western Railway	Do.
Central Argentine Railway	Do.
Buenos Ayres Midland	Do.
Entre Rios & Argentine North-Eastern FF.CC.E.R.	Do.
Entre Rios & Argentine North-Eastern F.C.N.E.A.	Do.
Egypt.	
Chemins de fer de l'Etat	997 milliems.
United States of America.	
Baltimore & Ohio Railroad	4.03 dollars.
Bessemer & Lake Erie Railroad	Do.
Great Britain.	
Great Western Railway	...
London Midland & Scottish Railway.	...
London & North-Eastern Railway.	...
Southern Railway	...
London Passenger Transport Board.	...
Africa.	
Kenya & Uganda Railway	...
South African Railways & Harbours	...
Sudan Railways	997 milliems.
Ceylon.	
Ceylon Government Railway	...
India.	
Great Indian Peninsula Railway (State Railway of India)	13.⅓ rupees.
North-Western Railway (State Railway of India)	Do.
South Indian Railway	Do.
Iraq.	
Iraqi State Railways.	...
New Zealand.	
New Zealand Government Railways	...

1. — *Give first costs of the various types of sleepers used upon fast or principal passenger lines (per sleeper) — per Appendix attached.*

ANSWER. — See Table 14.

2. — *The above appendix provides for the insertion of information in respect of the* first life *of the various types of sleepers. Where sleepers are recovered from fast or principal passenger lines what is the average percentage proportion of serviceable and scrap : and in the case of re-used sleepers, what is the average* additional *life :*

	% serviceable.	*Additional life. Years.*
(a) Timber		
(b) Steel		
(c) Concrete		

ANSWER. — See Table 15.

3. — *(a) Give cost (per sleeper) of the different preservation processes for each variety of* Timber *sleepers :*

Type of Timber.	Process.	1946.	1939.

(b) Where creosote or other types of oil are used in impregnation give description, average quantity absorbed, and cost per sleeper, of the various types included above. [*See A. 20 (e)*] :

	1946.	1939.

(c) Say if steel sleepers are coated with any preservative material. If so, give description and cost per sleeper :

	1946.	1939.

(d) Say if concrete sleepers are coated with any preservative material. If so, give description and cost per sleeper :

	1946.	1939.

ANSWER. — See Table 16.

4. — *Where timber sleepers are chaired by machine methods at sleeper depots give cost per sleeper :*

	1946.	1939.
Adzing		
Boring		
Chairing		

ANSWER. — See Table 17.

5. — *Give cost of packing or tamping sleepers (per mile/kilo) :*

	Shovel Packing.		Hand-beaters.		Pneumatic or Electric Beaters.	
	1946.	1939.	1946.	1939.	1946.	1939.
(a) With timber sleepers						
(b) With steel sleepers						
(c) With concrete sleepers						

ANSWER. — See Table 18.

TABLE No. 1

Name of Railway.	Total Running line.		Category 1.		Category 2.		Category 3.		Total Sidings Category 4.		Timber Sleepers.	
	Miles.	Km.	Miles.	Km.	Miles.	Km.	Miles.	Km.	Miles.	Km.	Miles.	Km.
Argentine.												
Buenos Ayres Great Southern Railway.	...	7377	...	...	...	...	...	...	...	...	...	5189
Buenos Ayres & Pacific Railway.	...	4836	...	1595	...	2655	...	586	...	1231	...	4340 ø
Buenos Ayres Western Railway	...	3320	...	...	...	3320	...	...	...	...	...	3087 ø
Central Argentine Railway . .	...	6483	...	...	...	2350	...	4133	...	1595	...	6428 ø
Buenos Ayres Midland . . .	...	516	...	...	...	516	...	...	...	73	...	492 ø
Entre Rios & Argentine North-Eastern FF.CC.E.R. . . .	...	1041	...	...	...	642	...	399	...	141	...	912 ø
Entre Rios & Argentine North-Eastern F.C.N.E.A. . . .	...	1209	...	...	...	686	...	523	...	101	...	1014 ø
Egypt.												
Chemins de fer de l'Etat . .	...	4494	...	...	...	4294	...	200	...	1646	...	5340 ø
United States of America.												
Baltimore & Ohio Railroad. .	...	...	8372	...	...	...	825	...	3157	...	12354x	...
Bessemer & Lake Erie Railroad	341	...	341	...	...	...	...	...	207	...	548x	...
Great Britain.												
Great Western Railway . . .	6629	...	4175	...	1592	...	862	...	2680	...	8612x	...
London Midland & Scottish Railway	13564	...	7460	...	4204	...	1900	...	6092	...	19572x	...
London & North-Eastern Railway	11859	...	5574	...	3786	...	2499	...	4952	...	16478x	...
Southern Railway	4151	...	2948	...	747	...	456	...	1367	...	5357x	...
London Passenger Transport Board	368	...	313	...	55	...	...	...	135	...	501x	...

Questions Nos. A 1, 2, 6 & 10).

Steel Sleepers.		*Concrete Sleepers (inc. blocks)*		*Other Materials.*		*Continuous Timber Beams.*		*Continuous Concrete Found.*		*Any Other Design.*		*Gauge of Track. (Question No. 10.)*
Miles.	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	
...	1785	...	...	...	C. 1. Pots 103	...	...	...	...	...	...	100 % 5'6"
...	470 Ø	...	...	...	C. 1. Pots 26Ø	...	...	...	...	...	...	100 % 5'6"
...	233 Ø	...	...	...	C. 1. Pots	...	...	...	...	...	...	100 % 5'6"
...	55 Ø	...	...	...	...	...	...	...	...	...	...	100 % 5'6" (small mileage mixed metre & 5'6").
...	24 Ø	...	...	...	...	...	...	...	...	...	...	100 % Metre.
...	129 Ø	...	...	...	...	...	...	...	...	...	...	100 % 4'8½"
...	24 Ø	...	...	...	C. 1. Pots 171Ø	...	...	...	...	...	...	100 % 4'8½"
...	800 Ø	...	...	...	...	...	...	...	...	...	...	100 % 4'8½" (No data given for additional 200 km. 2'5½" gauge.)
...	...	...	...	...	...	...	...	...	...	...	...	100 % 4'8½"
...	...	...	...	...	...	...	...	...	...	...	...	100 % 4'8½"
235x	...	437x	...	...	...	25x	...	...	...	...	...	100 % 4'8½"
43x	...	16x	...	...	...	25x	...	...	...	...	...	100 % 4'8½"
12x	...	259x	...	...	...	62x	...	Experimental.	...	Steel Beam Track Experimental.	...	100 % 4'8½"
90x	...	45x	...	...	...	26x	...	...	...	...	...	100 % 4'8½"
...	...	...	...	...	...	2x	...	...	...	...	...	100 % 4'8½"

TABLE No. 1

Name of Railway.	*Total Running line.*		*Category 1.*		*Category 2.*		*Category 3.*		*Total Sidings Category 4.*		*Timber Sleepers.*	
	Miles.	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*
Africa.												
Kenya & Uganda Railway . .	1625	...	...	...	1625	...	...	...	248	...	...	...
South African Railways & Harbours	12916	...	...	...	6581	...	6335	...	2257	...	10375x	...
Sudan Railways	...	3242	...	...	...	...	...	3242	...	432	...	1797 Ø
Ceylon.												
Ceylon Government Railway .	933	...	...	...	254	...	679	...	127	...	1060x	...
India.												
Great Indian Peninsula Railway (State Railway of India)	4203	...	...	...	4203	...	...	...	1293	...	95Ø	...
North-Western Railway (State Railway of India)	7776	...	3148	...	4001	...	627	...	2127	...	7183x	...
South Indian Railway . . .	2381	...	254	...	1431	...	696	...	556	...	849x	...
Iraq.												
Iraqi State Railways	997	...	...	...	...	...	997	...	166	...	971x	...
New Zealand												
New Zealand Government Railways	3764	...	...	...	1492	...	2272	...	990	...	4754x	...

Track Mileage.

Total Running Line . . . . 91 713. (147 597 km.)
Total Sidings . . . . . 29 597. (47 632 km.)

Total . . 121 310. (195 229 km.)

x Includes Sidings.
Ø Excludes Sidings.

Questions Nos. A 1, 2, 6 & 10). (Continued.)

Steel Sleepers.		*Concrete Sleepers. (inc. blocks)*		*Other Materials.*		*Continuous Timber Beams.*		*Continuous Concrete Found.*		*Any Other Design.*		*Gauge of Track (Question No. 10).*
Miles.	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	*Miles.*	*Km.*	
873	...	...	...	...	...	...	...	...	...	...	...	100 % Metre.
798x	...	...	...	...	...	...	...	...	...	...	...	100 % 3′6″ (No data given for additional 850 m. 2′0″ gauge.)
...	1445 Ø	...	...	...	...	...	...	...	...	...	...	100 % 3′6″
...	...	...	...	...	...	...	...	...	...	...	...	100 % 5′6″
973Ø	...	...	...	2200 C. I. Pots 936 C. I. Plates Ø	...	...	...	...	...	...	...	? 5′6″; ? 2′6″
679x	...	9x	...	2032 C. I. Potsx	...	...	...	...	...	...	...	92 % 5′6″; 8 % 2′6″
995x	...	...	...	C. I. Pots 1096 Experimental.	...	...	...	...	...	...	...	31 % 5′6″; 69 % Metre.
192x	...	...	...	...	...	...	...	...	...	...	...	32 % 4′8½″; 68 % Metre.
...	...	...	...	...	...	...	...	...	...	...	...	100 % 3′6″

Name of Railway.	(a) Per mile.	(a) Per kilometre.	(b)
Argentine.			
Buenos Ayres Great Southern Railway	...	1640 Hardwood. 1476 when base plates fitted.	22, 20 & 18
Buenos Ayres & Pacific Railway	...	1520 (to be 1760 in future).	19, future to 22.
Buenos Ayres Western Railway	...	1640 Hardwood. 1476 when base plates fitted.	22, 20 & 18
Central Argentine Railway	...	1400 to 1600.	17 to 18
Buenos Ayres Midland	...	1394	17
Entre Rios & Argentine North-Eastern FF. CC.E.R.	...	1395	17
Entre Rios & Argentine North-Eastern F.C. N.E.A.	...	1395	17
Egypt.			
Chemins de fer de l'Etat	...	1500	18
United States of America.			
Baltimore & Ohio Railroad	3429	...	24
Bessemer & Lake Erie Railroad	2970	...	22
Great Britain.			
Great Western Railway	2112	...	24
London Midland & Scottish Railway	2112	...	24
London & North-Eastern Railway	2200	...	25
Southern Railway	2112 & 2376	...	24 & 27
London Passenger Transport Board	2112	...	24
Africa.			
Kenya & Uganda Railway	2508 on 80 lb. track.	...	19
	2640 on 50 lb. track.	...	15
South African Railways & Harbours.	(1) 2376	...	18
	(2) 2112	...	16
	(3) 2080	...	13
Sudan Railways	...	1275 & 1311	14 & 12
Ceylon.			
Ceylon Government Railway	2112	...	12 & 18
India.			
Great Indian Peninsula Railway (State Railway of India)	2520	...	20
North-Western Railway (State Railway of India)	(1) 2200	...	17
	(2) (3) (4) 2000	...	15
South Indian Railway	Old 2000	...	16 & 18
	New 2340	...	15 & 17
Iraq.			
Iraqi State Railways	2200	...	15
New Zealand			
New Zealand Government Railways	2514	...	20

(c)	(d)	(e)	(f)
40 ft.	No.	...	0.51 m.
12.50 m.	No.	...	0.55 m.
40 ft.	No.	...	0.51 m.
40 ft. now 120 ft. chaired tracks 240 ft.	No.	...	24″
40 ft.	No.	...	0.72 m.
40 ft.	1 extra per rail.	...	20″
40 ft.	Do.	...	20″
12 m.	Do.	500 m.	.574 m. centre to centre with long plates. .200 m. centre to centre with short two hole plates.
39 ft.	No.	...	19½″
39 ft.	No.	...	19″ centre to centre sleepers for supported joint on 3 sleepers. Joint bars 3′2″ long.
60 ft.	Yes.	40 chains.	24¼″ centre of joint sleepers B.H. 11¼″ F.B.
60 ft.	2 extra per rail.	Do.	24¼″ centre of joint sleepers B.H. 11¼″ F.B.
60 ft.	No.	...	24¼″ centres of joint sleepers B.H. & F.B.
60 ft.	Up to 27 per rail.	60 chains for high speed tracks & 40 C. for lower.	24¼″ & 19¼″ B.H. 11¼″ F.B.
60 ft. & 300 ft. (experimental).	No.	...	25″ B.H.
40 ft. (80 lb.)	Only when rail joints are staggered	5° curves.	18″
30 ft. (50 lb.)		...	
40 ft. & (120 ft.)	No.	...	20″ (wood) 18″ (steel).
40 ft.	...	...	20″ (wood) 20″ (steel).
33 ft.	...	...	17½″ (wood) 14″ (steel).
36 ft. & 30 ft.	No.	...	20½″
30 ft. & 45 ft.	No.	...	14″
42 ft.	No.	...	11″ centres (wood) 14″ centres (C. 1.) 15″ centres (steel).
42 ft.	Yes, 1 or 2 per rail.	10° curve on 5′6″ gauge & 44° curves on 2′6″ gauge.	12″ centres (wood) 12″ to 15″ (steel and C. 1.).
42 ft.			
42 ft. (B.G.) 39 ft. (metre gauge)	No.	...	19″ centres and 11″ experimentally.
36 ft.	1 extra per rail.	573 ft.	19″ centres.
42 ft.	Do.	20 chains.	22″ centres.

TABLE No. 3 *(Question No. A 7).*

Name of Railway.	*Category 1.*		*Category 2.*		*Category 3.*		*Category 4.*		*Remarks.*
	Axle loading.	*Axle spacing.*	*Axle loading.*	*Axle spacing.*	*Axle loading.*	*Axle spacing.*	*Axle loading.*	*Axle spacing.*	
Argentine.									
Buenos Ayres Great Southern Railway	...	...	19.25 T.	...	17.0 T.	...	Not limited.	Not limited.	...
Buenos Ayres & Pacific Railway	22 T.	1.854 m.	18.3 T.	1.753 m.	14.2 T.	2.184 m.	...	...	...
Buenos Ayres Western Railway	...	...	19.25 T.	...	17.0 T.	...	Not limited.	Not limited.	...
Central Argentine Railway. .	18.25 T.	6′8″	18.25 T.	6′8″	16.5 T.	5′4½″	...	...	...
Buenos Ayres Midland . . .	...	...	12.35 Metric Tons.	5′6″	...	...	...	...	...
Entre Rios & Argentine North-Eastern FF.CC.E.R. . . .	...	...	12.5 T.	6′5¼″	11.5 T.	...	12.5 T.	6′5¼″	...
	...	...	12.0 T.	4′7″	...	...	12.0 T.	4′7″	...
Entre Rios & Argentine North-Eastern F.C.N.E.A. . . .	...	...	12.5 T.	6′5¼″	12.5 T.	6′5¼″	12.5 T.	6′5¼″	...
	...	...	12.0 T.	4′7″	...	...	12.0 T.	4′7″	...
Egypt.									
Chemins de fer de l'Etat . .	...	...	19.155 T.	...	...	...	17.155 T.	...	...
United States of America.									
Baltimore & Ohio Railroad. .	31.25 T.	5′7″	...	...	...	...	...	...	...
Bessemer & Lake Erie Railroad	33.9 T.	5′7″	...	...	...	...	...	...	...
Great Britain.									
Great Western Railway . . .	22.5 T.	8′0″	22.5 T.	8′0″	22.5 T.	8′0″	22.5 T.	8′0″	...
London Midland & Scottish Railway	22.5 T.	7′3″	22.5 T.	7′3″	22.5 T.	7′3″	22.5 T.	7′3″	...
London & North-Eastern Railway	22.05 T.	7′3″	22.05 T.	7′3″	22.05 T.	7′3″	22.05 T.	7′3″	...

Southern Railway	21.0 T.	7′6″	21.0 T.	7′6″	21.0 T.	7′6″	21.0 T.	7′6″	...
London Passenger Transport Board	22.05 T.	7′3″	22.05 T.	7′3″	22.05 T.	7′3″	22.05 T.	7′3″	...
Africa.									
Kenya & Uganda Railway	...	...	18.0 T.	4′6″	...	...	...	...	On 80 lb. track.
	...	...	12.0 T.	4′6″	...	...	...	...	On 50 lb. track.
South African Railways & Harbours	22 T.	5′0″	20.0 T.	5′6″	14.5 T.	4′9″	...	...	...
Sudan Railways	12.5 T.	5′3″	...	...	...	...	...	...	On 50 lb. track.
	16 T.	6′0″	...	...	...	...	...	...	On 75 lb. track.
Ceylon.									
Ceylon Government Railway	...	...	14.25 T.	...	13.0 T.	...	13.0 T.	...	...
India.									
Great Indian Peninsula Railway (State Railway of India)	22.5 T.	...	22.5 T.	...	18.0 T.	...	20.5 T.	...	Speed restriction 20 m.p.h. on Category 4
North-Western Railway (State Railway of India)	21.5 T.	6′7″	...	...	...	...	...	...	...
South Indian Railway	17.87 T.	5′1″	16.25 T.	...	16.0 T.	...	...	...	5′6″ gauge.
	...	...	17.525 T.	...	...	...	...	...	Metre gauge suburban electric.
	...	...	10.1 T.	...	9.68 T.	4′0″	...	...	Metre gauge main line.
Iraq.									
Iraqi State Railway	...	...	...	...	17.0 T.	6′6″	...	...	4′8½″ gauge.
	...	...	...	...	9.0 T.	5′0″	...	...	Metre gauge.
New Zealand									
New Zealand Government Railways	...	...	14.0 T.	4′9″	11.0 T.	4′9″	...	...	...

Showing the user (giving percentages where

Name of Railway.	*Qstn. 8 subdivn.*	*Question 14 (d) Country of Origin.*	*Argentine.*	*Argentine.*	*Argentine.*	*Turkey.*	*Australia.*	*Jugoslavia.*	*Canada.*	*Turkey.*	*U.S.A.*	*Baltic States.*	*Canada & U.S.A.*	*France & Portugal.*
		Variety of Timber.	*Quebracho Colorado.*	*Urunday.*	*Guayacan.*	*Karamani Pine.*	*Jarrah.*	*European Oak.*	*Canadian Oak.*	*Turkish Oak.*	*American Oak.*	*Baltic Redwood.*	*Douglas Fir & Oregon Pine.*	*Maritime Pine.*
Argentine.														
Buenos Ayres Gt. Southern Railway	a		100											
	b		100											
	c		100											
Buenos Ayres & Pacific Railway	a		100											
	b		100											
	c		100											
Buenos Ayres Western Railway	a		100											
	b		100											
	c		100											
Central Argentine Rly.	a		100											
	b		100											
	c		100											
Buenos Ayres Midland	a		100											
	b		100											
	c		100											
Entre Rios & Argentine North-Eastern FF.CC. E.R.	a		×	×	×									
	b		××	××	××									
	c		×	×	×									
Entre Rios & Argentine North-Eastern F.C.N. E.A.	a		×	×	×									
	b		××	××	××									
	c		×	×	×									
Egypt.														
Chemins de fer de l'Etat	a		...	...	...	×	×	×						
	b		...	...	...	...	×	...	×	×				
	c		...	...	...	×	×							
Unit. States of America.														
Baltimore & Ohio Railroad	a		.	...	...	...	...	...	...	...				
	b		...	...	...	...	...	...	...	...	×××			
	c		...	...	...	...	..	...	...	...				
Bessemer & Lake Erie Railroad	a		...	...	...	...	...	...	...	...				
	b		...	...	...	...	...	...	...	...	×××			
	c		...	...	...	...	...	...	...	...				
Great Britain.														
Great Western Railway.	a		...	...	...	...	...	...	...	...	...	100		
	b		...	...	...	...	...	...	...	...	...	18	52	11
	c		...	...	...	...	...	...	...	...	...	...	×	...
London Midland & Scottish Railway	a		...	...	...	...	...	...	...	...	...	68	21	3
	b		...	...	...	...	...	...	...	...	...	...	47	...
	c		...	...	...	...	...	...	...	...	...	...	×	...

(a), (b), (c), (d), and 14 (d).

available) of the different types of sleepers.

| | | |

TABLE No. 4 *(Questions Nos. A 8*

Showing the user (giving percentages where

Name of Railway.	*Qstn. 8 subdivn.*	*Question 14 (d) Country of Origin.*	*Argentine.*	*Argentine.*	*Argentine.*	*Turkey.*	*Australia.*	*Jugoslavia.*	*Canada.*	*Turkey.*	*U.S.A.*	*Baltic States.*	*Canada & U.S.A.*	*France & Portugal.*
		Variety of Timber.	*Quebracho Colorado.*	*Urunday.*	*Guayacan.*	*Karamani Pine.*	*Jarrah.*	*European Oak.*	*Canadian Oak.*	*Turkish Oak.*	*American Oak.*	*Baltic Redwood.*	*Douglas Fir & Oregon Pine.*	*Maritime Pine.*
London & North-Eastern Railway	a		...	...	...	...	...	...	...	...	...	50	30	15
	b		...	...	...	...	...	...	...	...	...	5	80	...
	c		...	...	...	...	...	...	...	...	...	...	×	...
Southern Railway	a		...	...	...	...	5	...	...	...	...	75	20	
	b		...	...	...	...	...	...	...	...	...	...	42	...
	c		...	...	...	...	...	...	...	...	...	...	×	...
London Passenger Transport Board	a		...	...	•	...	10	...	...	...	...	85	...	5
	b		...	...	...	...	10	...	...	...	...	×	×	×
	c		...	...	...	...	×	...	...	...	...	...	×	
Africa.														
Kenya & Uganda Rly.	a	ALL STEEL.												
	b	ALL STEEL.												
	c	ALL STEEL.												
South African Railways & Harbours	a		...	...	...	...	60	...	...	...	...	...	...	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c	Any source available.												
Sudan Railways	a		...	...	...	...	...	...	...	...	...	...	×	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c		...	...	...	...	...	...	...	...	...	...	×	...
Ceylon.														
Ceylon Government Railway	a		...	...	...	...	40	...	...	...	...	...	10	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c		...	...	...	...	×	...	...	...	...	...	×	...
India.														
Great Indian Peninsula Railway (State Railway of India)	a		...	...	...	...	20	...	...	...	...	...	...	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c		...	...	...	...	...	...	...	...	...	...	...	...
North-Western Railway (State Rly. of India)	a		...	...	...	...	...	...	...	...	...	...	...	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c		...	...	...	...	...	...	...	...	...	...	...	...
South Indian Railway	a		...	...	...	...	...	...	...	...	...	...	...	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c		...	...	...	...	...	...	...	...	...	...	...	...
Iraq.														
Iraqi State Railways	a		...	...	...	...	100							
	b		...	...	...	...	100							
	c		...	...	...	...	100							
New Zealand														
New Zealand Government Railways	a		...	...	...	...	...	...	...	...	...	...	...	...
	b		...	...	...	...	...	...	...	...	...	...	...	...
	c		...	...	...	...	...	...	...	...	...	...	...	...

(a), (b), (c), (d), and 14 (d). (Continued.)

available) of the different types of sleepers.

| | | |

TABLE No. 5 *(Questions Nos. A 9 & 29).*

Name of Railway.	*Question No. 9.*	*Percentage of track.*	*Question No. 29. Present weight of rails used in the lines.*			
			Category 1.	*Category 2.*	*Category 3.*	*Category 4.*
Argentine.						
Buenos Ayres Great Southern Railway	a	100	...	100 & 85 lb.	80, 74, 70, 58, 56 & 54 lb.	All classes.
	b	...	...	...	...	...
Buenos Ayres & Pacific Railway	a	100	100 & 85 lb.	100 & 70 lb.	70 & 50 lb.	...
	b	...	...	...	...	...
Buenos Ayres Western Railway	a	100	...	100 & 85 lb.	80, 74, 70, 58, 56 & 54 lb.	All classes.
	b	...	...	...	...	...
Central Argentine Railway.	a	100	100 & 85 lb.	100 & 85 lb.	75 & 65 lb.	...
	b	...	...	...	...	...
Buenos Ayres Midland	a	100	...	75 & 55 lb.	...	...
	b	...	...	...	...	...
Entre Rios & Argentine North-Eastern FF.CC.E.R.	a	100	...	75 lb.	75 lb.	...
	b	...	...	...	...	...
Entre Rios & Argentine North-Eastern F.C.N.E.A.	a	100	...	75 lb.	75 lb.	...
	b	...	...	...	...	...
Egypt.						
Chemins de fer de l'Etat	a	90	...	47, 46, 42 & 37.4 kgr.	47, 46, 42 & 37.4 kgr.	...
	b	10	...	42 & 38.6 kgr.	42 & 38.6 kgr.	...
United States of America.						
Baltimore & Ohio Railroad.	a	100	131 & 100 lb.	...	131 & 85 lb.	100 & 60 lb.
	b	...	...	...	...	...
Bessemer & Lake Erie Railroad	a	100	152, 131 & 130 lb.	...	...	...
	b	...	...	...	...	...
Great Britain.						
Great Western Railway	a	Experimental	113 lb.	...	...	...
	b	100	95 lb.	85 lb. serv.	Serv.	Serv.
London Midland & Scottish Railway	a	Experimental	113 lb.	...	...	...
	b	100	95 lb.	95 & 85 lb.	85 lb. & serv. BH equivalent to 85 lb.	Serv.

London & North-Eastern Railway	a	Experimental	110 lb.	...	...	...
	b	100	100, 95, 85 lb. & serv. BH ⊀ 87 lb.	95, 85 lb. and serv. BH. ⊀ 82 lb.	85 lb. & serv. BH ⊀ 78 lb.	Serv. BH ⊀ 74 lb.
Southern Railway	a	Experimental	113 lb.	...	...	...
	b	100	95 lb.	95 lb.	85 lb. Serv.	82 lb. Serv.
London Passenger Transport Board	a	Experimental	...	...	...	...
	b	100	95 lb.	95 lb.	95 lb.	95 lb.
Africa.						
Kenya and Uganda Railway	a	100	...	80 & 50 lb.	...	...
	b	...	...	...	...	...
South African Railways & Harbours	a	100	96 lb.	80 & 75 lb.	61 & 60 lb.	...
	b	...	...	...	...	...
Sudan Railways	a	100	75 & 50 lb.	75 & 50 lb.	75 & 50 lb.	75 & 50 lb.
	b	...	...	...	...	...
Ceylon.						
Ceylon Government Railway	a	100	...	88 lb.	80 lb.	80 lb.
	b	...	...	...	...	...
India.						
Great Indian Peninsula Railway (State Railway of India)	a	?	115, 100, 90 & 80 lb.	115, 100, 90 & 80 lb.	87, 80 & 75 lb.	80 & 60/62 lb.
	b	?	100 (DH), 100, 88½ (DH), 85 & 82 lb.	100 (DH), 100, 88½ (DH), 85 & 82 lb.	82 & 69 (DH) lb.	82, 75 (DH) & 69 (DH) lb.
North-Western Railway (State Railway of India)	a	61	87 lb.	75 & 62 lb.	60, 50, 41¼ & 35 lb.	75, 62, 60, 50, 41¼ & 35 lb.
	b	39	90 lb.	85, 84, 77½, 75 (DH), 73, 68 (DH) & 68 lb.	60 lb.	85, 84 77½, 75 (DH), 73, 68 (DH), 68 & 60 lb.
South Indian Railway 5'6"	a	?	90 lb.	90 & 75 lb.	90, 75 & 60 lb.	(All sections from 90 to 30 lb.)
	b	?	90 & 80 lb.	80 (Serv.) & 75 (DH) lb.	...	»
Metre.	a	?	...	75, 60 & 50 lb.	50, 41½, 40 & 35 lb.	»
	b	?	...	60 & 50 lb.	50 lb.	»
Iraq.						
Iraqi State Railways	a	100	...	...	75 & 50 lb.	...
	b	...	...	...	...	...
New Zealand						
New Zealand Government Railways	a	100	...	85 & 70 lb.	85 & 70 lb.	...
	b	...	...	...	...	...

TABLE No. (

Name of Railway.	*Question No. 12.*		
	(a) Length.	*(b) Width.*	*(c) Depth.*
Argentine.			
Buenos Ayres Great Southern Railway	2.74 m. (some 3.00 m.)	0.24 m.	0.12 m.
Buenos Ayres & Pacific Railway	2.74 m. (min. 2.70 m.)	0. 24 m. (min. 0.22 m.)	0.12 m. (0.11 to 0.13 m.)
Buenos Ayres Western Railway	2.74 m. (some 3.00 m.)	0. 24 m.	0.12 m.
Central Argentine Railway	2.74 m.	0. 24 m.	0.12 m.
Buenos Ayres Midland	2.00 m. (0.05 m. tolerance)	0. 24 m. (min. 0.22 m.)	0.12 m. (min. 0.11 m.)
Entre Rios & Argentine North-Eastern FF. CC.E.R.	2.5 m. (Tol. + 0.10 m. — 0.05 m.)	0.24 m. (Tol. ± 0.01 m.)	0.12 m. (Tol. ± 0.01 m.)
Entre Rios & Argentine North-Easthern F.C. N.E.A.	Do.	Do.	Do.
Egypt.			
Chemins de fer de l'Etat	2.60 m. to 2.65 m.	0.25 m. to 0.255 m.	0.15 m. to 0.165 m.
United States of America.			
Baltimore & Ohio Railroad	8′6″	6″ to 9″	6″ to 7″
Bessemer & Lake Erie Railroad	8′6″	75 % 9″; 15 % 8″ to 9″ 10 % 7″ to 8″	7″ min.
Great Britain.			
Great Western Railway	8′6″ (Tol. + 2″)	10″ (12″ Joint sleeper)	5″
London Midland & Scottish Railway.	Do.	Do.	Do.
London & North-Eastern Railway.	Do.	Do.	Do.
Southern Railway	Do.	Do.	Do.
London Passenger Transport Board	Do.	Do.	Do.
Africa.			
Kenya & Uganda Railway	All sleepers are steel.		
South African Railways & Harbours	7′0″ & 6′6″	10″ & 9″	5″ & 4½″
Sudan Railways	6′6″	9″	5″

(Questions Nos. A 12 & 13).

Question No. 13.		
(a) Wane.	*(b) Boxed hearts.*	*(c) Other Features.*
...	No mention.	0.018 m. sound wood must show on top face. Sapwood only allowed on top corners.
...	...	20 % of order can have minimum measure.
...	No mention.	0.018 m. sound wood must show on top face. Sapwood only allowed on top corners.
...	...	... Tolerance 0.10 m. horizontal arc.
Sleeper must be sound, without cracking splits or shakes or other defects that weather the sleeper. Borers and gum exudations are permitted, provided these do not damage the timber on the rail seat, nor in other manner prejudice the employment of same as a first class sleeper.	Do.	
...	...	Sleepers should be cut square & straight.
Not permitted on rail bearing areas between 20″ & 40″ from the middle.	Permitted.	Free from defects that impair the strength such as decay, large splits, large shakes, large and numerous knots or holes, and grain with a slant greater than 1 in. 15.
Permitted only within size limits.	...	...
1″ Wane permitted on each of 2 edges on one wide face. With Baltic Redwood, 3″ wane permitted on central 3′ of one wide face.	Not permitted prewar; subsequently 5 % of Douglas Fir.	Sound and straight grained, free from shakes, large, loose or unsound knots, reasonably free from sapwood (max. 25 % in Douglas Fir) Douglas Fir minimum 5 annual rings per inch. Permissable variation in width and depth ¼″.
Do.	Do.	Do.
Do.	Do.	Do.
Do.	Do.	Do.
Do.	Do.	Do.
1½″ to 2″.	Shall not be cut on full quarter.	Usual clauses.
Not permitted for imported sleeper. Some allowed between rail seats for native produced sleepers.	Not permitted for imported sleepers.	...

Name of Railway.	*Question No. 12.*		
	(a) Length.	*(b) Width.*	*(c) Depth.*
Ceylon.			
Ceylon Government Railway	9′0″	10″	5″
India.			
Great Indian Peninsula Railway (State Railway of India)	9′0″ & 5′0″ Not more than 5 % allowed a tolerance of — 2″ for 5′6″ gauge and — 1″ for 2′6″ gauge.	10″ & 7″. Not more than 5 % allowed a tolerance of — $\frac{1}{4}$″ for 5′6″ & 2′6″ gauge.	5″ & 4$\frac{1}{2}$″ Not more than 5 % allowed a tolerance of — $\frac{1}{8}$″ for 5′6″ & 2′6″ gauge.
North-Western Railway (State Railway of India)	9′0″	10″	5″
South Indian Railway	9′0″ for 5′6″ gauge (Tol. 3″) 6′0″ for metre (Tol. 2″).	10″ for 5′6″ gauge (Tol. 1″) 8″ for metre gauge (Tol. 1″).	5″ for 5′6″ gauge (Tol. $\frac{1}{4}$″) 4$\frac{1}{2}$″ for metre gauge (Tol. $\frac{1}{4}$″).
	No sleeper can be undersized in both width and depth. Tolerances quoted are for 10 % sleepers only.		
Iraq.			
Iraqi State Railway.	8′6″ for 4′8$\frac{1}{2}$″ gauge. 5′0″ for metre gauge.	10″ for 4′8$\frac{1}{2}$″ gauge. 8″ for metre gauge.	5″ for 4′8$\frac{1}{2}$″ gauge. 4$\frac{1}{2}$″ for metre gauge.
New Zealand.			
New Zealand Government Railways	7′0″. Tolerance — 1″ or + 2″.	8″	5″

Question No. 13.		
(a) Wane.	*(b) Boxed hearts.*	*(c) Other Features.*
Not permitted under rail seat and not to exceed 2″ on either face.	...	Free from heart shakes, no sap or dry rot.
Half the tolerances for sapwood.	Sleepers with boxed hearts must not exceed 10 % of the total (conditions of cutting, and position of heart are specified).	Sapwood at rail seat must not exceed 25 % of any surface dimension for 4″ either side of centre line of rail. Elsewhere, must not exceed 50 %. Conditions are also specified for : cracks, splits, crook, cup, twist, warp, damage by fire, decay, heart defects, hollows, knots and scars insect attack, ruptured ends sawing defects and shakes.
1″ limit, provided it does not cause an excess of 10 % sapwood.	Not more than 1¼″ from nearest edge of sleeper.	Max. spring 2″. Max. cup ½″. Max. winding ¼″. Max. tight knot within 6″ from centre line of rail seat 1″ dia. Largest tight knot away from rail seat 3″ dia.
Width of sleepers at rail seats to be not less than 9″ for 5′6″ gauge & 7″ for metre gauge. At middle & ends section must not be reduced by more than 7½ %. In any position, the sum of areas of sapwood and wane must not exceed the allowances for sapwood alone.	Not permitted at both ends with MUTTI. Other species, if sound and free from splits permitted as follows: Centre heart within 1″ of nearest surface in Class II sleepers. Centre heart one end only if within 1½″ of nearest side face. Both ends if clamped both ends in Low Grade sleepers.	End splits, cracks, heart defects. Quartering, winding heart, cup and ring shakes, hollows, knots, scars, fungal attack, insect holes, are all specified as to allowances.
Jarrah sleepers. — Wane not to exceed 1″ measured on the level on two edges, or 1½″ if on one edge only.	Jarrah sleepers. — Free from heart.	Jarrah sleepers. — To be hewn or sawn square & straight. To measure at time of cutting ¼″ wider and 1/8″ thicker than nominal size. Length, tolerance ± 1″. They shall not be cut on the quarter. Provided strength, durability and spike holding capacity at rail seat are not unduly impaired, following defects allowed : Tight gum veins & small gum pockets. End splits or shakes not exceeding 1″ per ft. of length occasional pinholes, camber or twist not be to exceed ½″ if clear of rail seat, sound knots, up to 2″ dia. or clean knotholes up to 1¼″. Sap across face of sleeper not to exceed 1/8″ in depth at the centre.
Not to exceed 1″ on the edges or 1½″ on one edge provided that the rail seat shows at least 6″ of true wood.	Not acceptable in Eucalyptus.	Bon and twist not to exceed ½″ : Spring not to exceed 2″.

Name of Railway.	*Question No. 16.*	*Question*	
		(a)	*(b)*
Argentine.			
Buenos Ayres Great Southern Railway	...	No.	No.
Buenos Ayres & Pacific Railway	Only Quebracho Colorado used. Preferably felled in Autumn and Winter.	No.	No.
Buenos Ayres Western Railway	...	No.	No.
Central Argentine Railway	...	Yes.	No.
Buenos Ayres Midland	...	Yes.	No.
Entre Rios & Argentine North-Eastern FF. CC.E.R.	No seasonal restrictions.	Yes.	No.
Entre Rios and Argentine North-Eastern F.C. N.E.A.	Do.	Yes.	No.
Egypt.			
Chemins de fer de l'Etat	...	Already seasoned	
United States of America.			
Baltimore & Ohio Railroad	...	Yes.	No.
Bessemer & Lake Erie Railroad	...	Yes.	No.
Great Britain.			
Great Western Railway	Baltic redwood winter felled. Other types no restriction.	Yes.	No.
London Midland & Scottish Railway	Do.	Yes.	No.
London & North-Eastern Railway	Do.	Yes.	No.
Southern Railway	Do.	Yes.	No.
London Passenger Transport Board	Do.	Yes.	No.
Africa.			
Kenya & Uganda Railway	No timber sleepers used.		
South African Railways & Harbours	In proper season from mature trees.	Already seasoned	
Sudan Railways	Certain varieties reserved for other uses.	Yes.	Some.
Ceylon.			
Ceylon Government Railway	Yes.	Yes.	No.
India.			
Great Indian Peninsula Railway (State Railway of India)	Yes.	No.	No.
North-Western Railway (State Railway of India)	Felled in Autumn.	Yes.	No.
South Indian Railway	No felling restrictions.	Yes.	No.
Iraq.			
Iraqi State Railways	...	...	...
New Zealand.			
New Zealand Government Railways	No felling restrictions.	Yes.	No.

No. 17. (c)	Question No. 18.	Question No. 19. (a)	Question No. 19. (b)
No.	...	Machinery.	Both.
No.	...	Both methods.	Own forces.
No.	...	Machinery.	Both.
No.	6 months.	Machinery.	Both.
No.	6 months.	Hand.	Contract.
No.	6 months.	Hand (electric drill).	Mostly contract.
No.	6 months.	Hand (electric drill).	Mostly contract.
when received.	...	Machinery.	Own forces.
Boulton method.	Oak 12-14 months. Other woods 3-6 months.	...	...
No.	...	Machinery.	Own forces.
No.	Baltic redwood 9 months. Douglas Fir 6 months.	Machinery.	Both.
No.	Do.	Machinery.	Own forces.
No.	Do.	Bored by machinery. Adzing not done.	Own depots.
No.	Do.	Machinery.	Both.
No.	Do.	Do.	Do.
when received.	...	Both (Hand machine).	Own forces.
Drying Kilns experimentally.	Imported green and creosoted on arrival.	Machinery.	Own forces.
No.	12 months.	Imported, by machinery. Home grown, by hand.	Do.
No.	...	Both methods.	Own forces.
No.	2-6 months.	Bored by hand. Adzed by machine.	Do.
No.	...	Hand.	Do.
...	...	Machinery.	Do.
No.	6 months.	Both methods.	...

TABLE No. 8

Name of Railway.	*(a)*	*(b)*
Argentine.		
Buenos Ayres Great Southern Railway	No.	...
Buenos Ayres & Pacific Railway	No.	...
Buenos Ayres Western Railway	No.	...
Central Argentine Railway	No.	...
Buenos Ayres Midland	No.	...
Entre Rios & Argentine Nort-Eastern FF.CC. E.R.	No.	...
Entre Rios & Argentine North-Eastern F.C. N.E.A.	No.	...
Egypt.		
Chemins de fer de l'Etat	No.	Only black washed under saddles.
United States of America.		
Baltimore & Ohio Railroad	Treated.	Rueping. Initial pressure 100 lb./sq. in. Temperature of oil 165°-200° F. Pressure held at 175 lb./sq. in. Final vacuum 22″ for 30 min.
Bessemer & Lake Erie Railroad	Treated.	Rueping as specified by the American Railway Engineering Association.
Great Britain.		
Great Western Railway	Treated.	*Creosoting.* Vacuum 25″ per 15 min. Temperature 160° F. Pressure 60-90 lb./sq. in. for Baltic redwood. Pressure 200 lb. /sq. in. for Douglas Fir. held up to 4½ hours (D. Fir). Final vacuum 25″ for 15 min.
London Midland & Scottish Railway	Treated.	*Creosoting.* Vacuum 27″ for 15 min. Temperature 140-200° F. Pressure 200 lb./sq. in. up to 3 hours (D. Fir). Final vacuum for 20 min. *Wolmanising* experimentally for about 2 years. Process as for creosoting.
London & North-Eastern Railway	Treated.	*Creosoting.* Vacuum 26″ for 20 min. Temperature 185° F. Pressure 130-180 lb./sq. in. up to 3 hours (D. Fir). No final vacuum. Drain for 1 hour. Wolmanising experimentally.

(Question No. A 20).

(c)	*(d)*	*(e)*
...	...	...
...	...	...
...	...	...
...	...	...
...	...	...
...	...	...
...	...	...
...	...	...
Empty cell.	A.W.P.A. stand. specification for creosote coal tar solutions (1942).	All types 7 lb. per cu. ft.
Empty cell.	80-20 creosote coal tar solution.	6 lb. per cu. ft. min.
Full cell.	Creosote to B.S.S. 144 (1936) Type A.	Baltic Redwood $2\frac{3}{4}$-3 gal. per sleeper. Douglas Fir $1\frac{1}{4}$-$2\frac{1}{4}$ gal. per sleeper Other types 1-3 gal. per sleeper.
Full cell.	Creosote to B.S.S. 144 (1936) Type A. Wolman Salt. « Tanalith » salts to specification of Messrs. Hickson & Welch Ltd. Castleford, Yorkshire & England. 4 % and 2 % solutions.	Baltic Redwood $2\frac{1}{2}$-3 gal. per sleeper. Douglas Fir $1\frac{1}{4}$-$2\frac{1}{4}$ gal. per sleeper. Other types 1-3 gal. per sleeper. Wolman salts, deposit of 4 oz. dry salts per cu. ft. with the 4 % solution.
Full cell.	Ditto but 2 % Wolman salts only used.	Baltic Redwood 2.9 gal. per sleeper. Douglas Fir 1.5 gal. per sleeper. Other types 1.3 gal. per sleeper.

TABLE No. 8

Name of Railway.	*(a)*	*(b)*
Southern Railway	Treated.	*Creosoting.* Vacuum 25″. Temperature 140° F. Pressure 200 lb./sq. in. up to 3 hours (D. Fir). No final vacuum. Drain ½ hour.
London Passenger Transport Board	Treated.	*Creosoting.* Vacuum 25″ for 10 minutes. Pressure 160 lb./sq. in.
Africa.		
Kenya and Uganda Railway.	No timber sleepers used	
South African Railways & Harbours	Softwoods (not now used) were treated in the past.	Creosote.
Sudan Railways	Treated.	*Creosoting.* Pressure 170 lb./sq. in. for 2 hours. Temperature 150° F. Drainage by compressed air at 20 lb./sq. in.
Ceylon.		
Ceylon Government Railway	Treat imported but not local.	Rueping.
India.		
Great Indian Peninsula Railway (State Railway of India)	No.	...
North-Western Railway (State Railway of India)	Treat coniferous woods only.	*Rueping.* Initial pressure 55lb./sq. in. for 20 min. Pressure 175 lb./sq. in. for 30 min. Final vacuum 24″ for 20 min. *Creosoting.* — Full cell. Initial vacuum 24″ for 45 min. Pressure 175 lb./sq. in. for 5 min. Final vacuum 24″ for 30 min.
South Indian Railway	...	...
Iraq.		
Iraqi State Railways	No.	...
New Zealand.		
New Zealand Government Railways	No.	...

(Question No. A 20). (Continued.)

(c)	*(d)*	*(e)*
Full cell.	Creosote to B.S.S. 144 (1936) Type A.	Baltic Redwood 3 gal. per sleeper. Douglas Fir 2¼ gal. per sleeper. Other types 1-3 gal. per sleeper.
Full cell.	Creosote to B.S.S. 144 (1936) Type A.	Baltic Redwood 3 gal. per sleeper. Douglas Fir 2¼ gal. per sleeper. Other types 1-3 gal. per sleeper.
Full cell.		
Full cell.	50 % creosote 50 % fuel oil.	3.3 kgr. per cu. ft.
Empty cell.	60 % creosote 40 % petroleum.	7 lb./cu. ft. for Douglas Fir.
Empty cell for Chir.	To specification No. G/OP-330 of Indian Stores Dept. Mixture of 40 % creosote and 60 % liquid fuel oil.	Chir. 15 lb. per sleeper.
Full cell for Deodar, Fir and Kail.	...	Fir and Kail. 15 lb. per sleeper. Deodar. 10 lb. per sleeper.
...	...	...
...	...	...
...	...	...

TABLE No. 9

Name of Railway.	*(a)*	*(b)*
Argentine.		
Buenos Ayres Great Southern Rly.	Yes.	Serviceable fit for main line. Serviceable fit for sidings. Firewood.
Buenos Ayres & Pacific Railway . .	»	« A » New. « B » Used but suitable for re-use in main line. « C » Suitable for sidings. « D » Unsuitable for tracks work. The grading is according to mechanical damage and number of spike holes.
Buenos Ayres Western Railway . .	»	Serviceable fit for main line. Serviceable fit for sidings. Firewood.
Central Argentine Railway	»	Secondary lines 10 %. Sidings 25 %. Fence posts 30 %. Other uses 15 %. Firewood 20 %.
Buenos Ayres Midland	»	Second class (serviceable). Firewood.
Entre Rios & Argentine North-Eastern FF.CC.E.R.	»	Grade 1 Fit to return to main line. Grade 2 Fit for lower category or sidings. Grade 3 Fit for fence posts, etc. Grade 4 Firewood.
Entre Rios & Argentine North-Eastern F.C.N.E.A.	»	Do.
Egypt.		
Chemins de fer de l'Etat	»	Secondhand. Serviceable scrap. Scrap.
United States of America.		
Baltimore & Ohio Railroad	No definite system, depends on official inspection.	...
Bessemer & Lake Erie Railroad . .	Yes.	Fit for side tracks. Unfit for further use.
Great Britain.		
Great Western Railway	Yes.	Grade 1 Sound sleepers no real defects. Grade 2 Sound sleepers holes elongated, slightly chairworn, surface shakes. Grade 3 Impaired holes, considerably chairworn, slight splitting, no decay. Grade 4 Slightly split each end upto chair seat, no appreciable decay. Grade 5 Split & decayed but ban be handled.
London Midland & Scottish Railway.	»	Grade 6 Extensive splitting and decay. Do.

(Question No. A 27).

(c)	*(d)*	*(e)*	*(f)*
...	Best of class « Serv. for main line ».	Serv. for main line.	Serv. for sidings.
« A »	« A »	« A »	A-B & C according to importance of this siding.
...	Best of class « Serv. for main line ».	Serv. for main line.	Serv. for sidings.
...	...	...	...
...	First class.	...	Second class.
...	New first class or Grade I.	New first class or second class.	New second class & grade 2. (New first class at joints if important siding.)
...	Do.	Do.	Do.
...	Secondhand in secondary branches.	...	Secondhand.
...	...	...	...
Full size 7″×9″ & scant size 7″×8″.	...	...	Full size 7″×9″ & scant sizes down to 7″×7″.
New & Grade I.	New & Grades 1 and 2.	New & Grades 1 and 2.	Grades 2, 3 & 4.
Do.	Do.	Do.	Do.

TABLE No. 9

Name of Railway.	*(a)*	*(b)*
London & North-Eastern Railway .	»	Do.
Southern Railway	»	Do.
London Passenger Transport Board .	»	Do.
Africa.		
Kenya & Ugand Railway.	Only steel sleepers used.	...
South African Railways & Harbours	Yes.	New Class I. Serviceable class II. Sound, free from large cracks, not more than 2 holes each end. Serviceable class III. Sound, free from large cracks, not less than 2 holes nor more than 4 holes each end.
Sudan Railways	»	Serviceable. Firewood.
Ceylon.		
Ceylon Government Railway . . .	»	Grade I to patch running lines. Grade II for sidings.
India.		
Great Indian Peninsula Railway (State Railway of India)	»	Class II fit to be reused in tracks. Class III unfit for further use.
North-Western Railway (State Railway of India)	»	Serv. fit for reuse in line. USB. Unfit for line, fit for building. FFW. Fit for firewood. Scrap. in pieces.
South Indian Railway.	»	Grades I & II Quite good and serv. sleepers, ends not split and rail seat or bearing plate not cut into sleeper. (I is better than II.) Grade III. Slight cracks at ends and dents at rail seat. — Reuse in non-running lines. Grade $\frac{III}{III}$. Not fit for reuse in tracks unless cut into blocks from serviceable portions.
Iraq.		
Iraqi State Railways	»	Fit for sidings. Unserviceable.
New Zealand.		
New Zealand Government Railways.	»	Grade I. FA for reuse in main lines. Grade II. FA for reuse in sidings. Grade III. Suitable for fence posts. Grade IV. Firewood.

(Question No. A 27). (Continued.)

(c)	*(d)*	*(e)*	*(f)*
Do.	Do.	Do.	Do.
Do.	Do.	Do.	Do.
Do.	Do.	Do.	Do.
...	...	...	...
Class I.	Class I.	Classes 1 & 2.	Class 3.
Serv. for spot sleepering.	...	...	Serviceable.
...	Grade I.	Grade II.	Grade II.
Class I.	Class I.	Class I.	Class II.
New.	New & Serv.	New & Serv.	New & Serv.
Grades I & II.	Grades I & II.	Grade II.	Grades III and $\frac{III}{III}$.
...	...	Fit for main line.	Fit for sidings.
...	New.	New or Grade 1 serv.	Grade II serv.

Name of Railway.	*(a)*	*(b)*	*(c)*
Argentine.			
Buenos Ayres Great Southern Rly.	F.B.	Mostly direct, some Cast steel baseplates.	...
Buenos Ayres & Pacific Railway . .	F.B.	Mostly direct, but future renewals with soleplates.	Almost 100 % dog spikes.
Buenos Ayres Western Railway . .	F.B.	Mostly direct, some Cast steel baseplates.	...
Central Argentine Railway	F.B.	Direct, except on Buenos Ayres Suburban lines where plates are used.	97.7 % direct 2.3 % plates.
Buenos Ayres Midland	F.B.	Direct.	100 % spikes.
Entre Rios & Argentine North-Eastern FF.CC.E.R.	F.B.	»	Do.
Entre Rios & Argentine North-Eastern F.C.N.E.A.	F.B.	Direct.	100 % spikes.
Egypt.			
Chemins de fer de l'Etat	B.H & F.B.	Chairs & baseplates.	Coach screws.
United States of America.			
Baltimore & Ohio Railroad	F.B.	Tie plates.	Spikes (Screws?)
Bessemer & Lake Erie Railroad . .	F.B.	Tie plates.	...
Great Britain.			
Great Western Railway	B.H. & F.B.	Chairs for B.H. Baseplates for F.B.	...
London Midland & Scottish Railway.	B.H. & F.B.	Chairs for B.H. Baseplates for F.B.	...

(Question No. A 28).

(d)	(e)	(f)	(g)	(h)	(j)	(k)
No.	...	Yes.	$5^{3}/_{8}'' \times {}^{7}/_{8}''$, with $^{13}/_{16}''$ boring.	Dog spikes.	$\frac{3}{4}''$ with $\frac{3}{4}''$ boring.	No device.
A few $^{7}/_{8}''$ with $^{57}/_{64}''$ borings.	...	Yes.	$^{7}/_{8}''$ boring through sleeper.	Do.	$\frac{3}{4}''$ & $^{7}/_{8}''$ with $\frac{3}{4}''$ and $^{29}/_{32}''$ borings.	Do.
No.	...	Yes.	$5^{3}/_{8}'' \times {}^{7}/_{8}''$ with $^{13}/_{16}''$ boring.	Do.	$\frac{3}{4}''$ with $\frac{3}{4}''$ boring.	Do.
Only in S. & D. works but not on electrified tracks. $^{7}/_{8}''$ with $^{15}/_{16}''$ borings.	Not used on T.C.'s.	Yes, on Buenos Ayres Suburban.	$^{7}/_{8}''$ with $\frac{3}{4}''$ boring.	Dog spikes trying spring spikes.	$^{13}/_{16}''$ & $^{7}/_{8}''$ square with $^{7}/_{8}''$ & $^{15}/_{16}''$ boring.	Do.
...	...	...	...	Dog spikes.	$^{5}/_{8}''$ sq. with $^{5}/_{8}''$ boring.	Do.
...	No.	Yes, on S. & C. work, sleepered bridges & Hardwood culvets.	$4^{5}/_{8}''$ under head $\times \frac{3}{4}''$ with $^{5}/_{8}''$ boring.	Do.	$4^{11}/_{16}''$ under head $\times \frac{3}{4}''$ sq. with $\frac{3}{4}''$ boring.	Do.
...	No.	Yes, on S. & C. work, sleepered bridges & Hardwood culvets.	$4^{5}/_{8}''$ under head $\times \frac{3}{4}''$ with $^{5}/_{8}''$ boring.	Do.	$4^{11}/_{16}''$ under head $\times \frac{3}{4}''$ sq. with $\frac{3}{4}''$ boring.	Do.
...	...	Yes.	$5^{29}/_{32}'' \times \frac{3}{4}''$ with $^{5}/_{8}''$ boring.	No.	...	Do.
No.	...	No.		No.	...	Do.
No.	...	No.	$6\frac{1}{2}'' \times {}^{15}/_{16}''$ screw spikes to fasten tie plates to ties, boring $6'' \times {}^{5}/_{8}''$.	Hooked head spikes to fasten rails.	Not bored for rail spikes.	Do.
Yes $^{7}/_{8}''$ bolt & borings.	No.	Occasionally	$6^{3}/_{8}''$, under head $\times$ 1" diam. under head. Core of thread $\frac{3}{4}''$ at top to $^{11}/_{16}''$ at bottom. Borings $^{11}/_{16}''$ dia.	Spring spikes with F.B. only.	$^{5}/_{8}''$ sq. with $\frac{1}{2}''$ boring.	Do.
Yes, $^{7}/_{8}''$ bolt & boring in small quantity.	No.	Yes.	$6\frac{3}{4}''$ under head $\times$ 1" diam. under head. Core of thread $\frac{3}{4}''$ at top to $^{11}/_{16}''$ at bottom. Borings $^{11}/_{16}''$ dia.	Spring spikes with F.B. only.	$^{5}/_{8}''$ sq. with $\frac{1}{2}''$ boring.	No device.

Name of Railway.	*(a)*	*(b)*	*(c)*
London & North-Eastern Railway .	B.H. & F.B.	Do.	...
Southern Railway	B.H. & F.B.	Do.	...
London Passenger Transport Board .	B.H. & F.B.	Do.	...
Africa.			
Kenya & Uganda Railway	...	Steel sleepers only used.	...
South African Railways & Harbours	F.B.	Mostly soleplates & chairs.	60 % soleplates & 40 % chairs.
Sudan Railways	F.B.	Bearing plates.	Mostly plain plate & 2 coach screws. Small amount of G.E.O. plates using 2 coach screws & 2 bolts & clips.
Ceylon.			
Ceylon Government Railway . . .	F.B.	Direct.	Holding down bolts at joints. Remainder dog spikes.
India.			
Great Indian Peninsula Railway (State Railway of India)	B.H. & F.B.	B.H. chairs used 100 %. F.B. direct 60 % & C.I. plates 40 %.	Fangbolst & dog spikes.
North-Western Railway (State Railway of India)	F.B. F.B. & D.H.	Hardwood sleepers F.B. only laid direct. Coniferous sleepers F.B. have bearing plates. B.H. & D.H. are in C.I. Chairs.	90 % F.B. have dog spikes. 10 % F.B. have keys driven between rail foot & tapered jaws of C.I. base-plates.
South Indian Railway.	F.B.	Bearing plates & anti-creep chairs at joints & special portions over girder bridges & intermediate sleepers where speeds are high. Other places direct to sleeper.	Dog spikes mostly with coach screws in special places.
Iraq.			
Iraqi State Railways	F.B.	Direct.	...
New Zealand.			
New Zealand Government Railways.	F.H.	Both.	On straight track, 2 slprs. each side of joint have tie plates & screws spikes, remainder dog spikes. On curved track, extra tie plates are used. On sharp curves plates used on every sleeper.

(Question No. A 28). (Continued.)

(d)	*(e)*	*(f)*	*(g)*	*(h)*	*(j)*	*(k)*
$^{7}/_{8}$″ bolt & hole for test length of F.B. track only.	...	Yes.	Do.	Do.	Do.	Do.
Yes, $^{7}/_{8}$″ bolt & holes.	No.	Yes.	Do.	Do.	Do.	Do.
No.	...	Yes.	Do.	Do.	Do.	Do.
...	...	...	...	...	...	...
No.	...	Yes.	$4^{5}/_{8}$″ — $5\frac{3}{4}$″ long × $^{7}/_{8}$″ diam. Borings $\frac{1}{2}$″ softwood & $^{11}/_{16}$″ hardwood.	Few dog spikes.	$\frac{3}{4}$″ sq. with borings $\frac{1}{2}$″ softwood & $^{5}/_{8}$″ hardwood.	Do.
No.	No T.C.'s.	Yes.	$^{5}/_{8}$″ & $\frac{3}{4}$″ screw-spikes for 50 & 75 lb. rails. Borings $^{1}/_{8}$″ less in hardwood & $\frac{1}{4}$″ less in softwoods.	Experimenting with spring.	...	Do.
$^{7}/_{8}$″ in $^{7}/_{8}$″ borings.	No.	No.	...	Both.	Dog spikes $^{7}/_{8}$″ in $^{7}/_{8}$″ borings. Spring spikes $^{5}/_{8}$″ in $^{9}/_{16}$″ borings.	Do.
Fangbolts $\frac{3}{4}$″ & $^{7}/_{8}$″ dia. in $^{5}/_{8}$″ $\frac{3}{4}$″ borings.	Yes.	No.	...	Dog spikes.	$^{5}/_{8}$″ sq. in $^{5}/_{8}$″ borings.	Do.
No.	...	No.	...	Dog spikes.	$5^{3}/_{8}$″ × $^{5}/_{8}$″ sq $\frac{1}{2}$″ borings in treated Deodar, Chir, Kail & Fir. $^{5}/_{8}$″ in hardwood.	Do.
No.	...	A few.	...	Dog spikes.	$^{5}/_{8}$″ holes through sleeper.	Do.
...	...	No.	...	Dog spikes.	$^{5}/_{8}$″ in $^{5}/_{8}$″ borings.	No device.
No.	...	Yes.	$^{5}/_{8}$″ diam. sleepers bored right through $^{9}/_{16}$″ dia.	Do.	$^{9}/_{16}$″.	Do.

TABLE No. 11.

Name of Railway.	*Question* (a)	*Question* (b)
Argentine.		
Buenos Ayres Great Southern Railway.	2.74 m. × 0.25 m. × 0.09 m.	Type 4.
Buenos Ayres & Pacific Railway . . .	2.79 m. × 0.254 m.	»
Buenos Ayres Western Railway . . .	2.74 m. × 0.25 m. × 0.09 m.	»
Central Argentine Railway	9′0″ × 9¾″ × 3⅝″	»
Buenos Ayres Midland.	...	»
Entre Rios & Argentine North-Eastern FF.CC.E.R.	No longer standard. — Not now permitted by Argentine Law.	...
Entre Rios & Argentine North-Eastern F.C.N.E.A.	Do.	...
Egypt.		
Chemins de fer de l'État	2.50 m. × 0.25 m. × 0.85 m. deep × 0.013 m. thick.	Type 4 turned down ends.
United States of America.		
Baltimore & Ohio Railroad	Not used.	...
Bessemer & Lake Erie Railroad . . .	Not used.	...
Great Britain.		
Great Western Railway	Guest, Keen & Nettlefold. 8′6″ × 11″ × 3″ & 8′6″ × 10¼″ × 3″ Sandberg 8′0″ × 11 3/16″ × 2 9/16″ (1″ rib on top surface). Workington 8′6″ × 11¼″ × 2⅝″ Ebbw Vale 8′6″ × 10¼″ × 3 5/16″ Dorman Long 8′6″ × 11″ × 3″	Type 4, but Sandberg type has central rib on top & ends turned down.

(Questions Nos. A 31, 32 & 36).

No. 31.		*Question No. 32.*					*Question No. 36.*	
(c)	*(d)*	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(a)*	*(b)*
62 kgr. (Twin bolts 2 kgr. each).	All same type.	Two $^{7}/_{8}$" bolts and clips.	No.	No.	Yes.	To slight extent.	100 %	...
73 kgr. without fittings.	»	$^{7}/_{8}$" sq. neck bolts Rect. hole, $^{15}/_{16}$" wide.	No.	No.	Yes.	Certain amount. 1905 sleepers still giving good service.	100 %	...
62 kgr. (Twin bolts 2 kgr. each).	»	Two $^{7}/_{8}$" bolts & clips.	No.	No.	Yes.	To slight extent.	100 %	...
65 kgr. (No base plate).	»	$^{13}/_{16}$" dia. hook bolt & clips.	No.	No.	Yes.	Yes.	100 %	...
42 kgr. without bolts.	»	Clips & 19 mm. bolts in 20.6 mm. holes.	No.	No.	Yes.	Not perceivable.	100 %	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
68 kgr. inc. bolts & clips.	»	Clips & 22 mm. bolts in 24 mm. holes.	No.	No.	Yes.	Certain amount.	100 %	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
180 to 245 lb. with chairs.	98 %	No.	Yes.	Yes.	No bolts used.	...	...	100 %
	2 %							

TABLE No. 11

Name of Railway.	*Questio*	
	(a)	*(b)*
Great Britain.		
London Midland & Scottish Railway .	Guest, Keen & Nettlefold. 8′6″ × 11″ × 3″ & 8′6″ × 10¼″ × 3″ Sandberg 8′0″ × 11$^{3}/_{16}$″ × 2$^{9}/_{16}$″ (1″ rib on top surface). Workington 8′6″ × 11¼″ × 2$^{5}/_{8}$″ Ebbw Vale 8′6″ × 10¼″ × 3$^{5}/_{16}$″ Dorman Long 8′6″ × 11″ × 3″	Type 4, but Sandberg type has central rib on top & ends turned down.
London & North-Eastern Railway . . .	Guest, Keen & Nettlefold. 8′6″ × 11″ × 3″ & 8′6″ × 10¼″ × 3″	Type 4.
	Workington 8′6″ × 11¼″ × 2$^{5}/_{8}$″	Type 4.
	Ebbw Vale 8′6″ × 10¼″ × 3$^{5}/_{16}$″	Type 4.
	Dorman Long 8′6″ × 11″ × 3″	Type 4.
	Cargo Fleet 8′6″ × 10″ × 2¼″	Type 2.
	Tees Side 8′6″ × 10″ × 3¾″	Types 2 & 3 combined with ends turned up.
Southern Railway	Sandberg 8′0″ × 11$^{3}/_{16}$″ × 2$^{9}/_{16}$″ (1″ rib on top surface). Workington 8′6″ × 11¼″ × 2$^{5}/_{8}$″ Dorman Long 8′6″ × 11″ × 3″	Type 4, but Sandberg has central rib on top & ends turned down.
London Passenger Transport Board .. .	Not used.	...
Africa.		
Kenya & Uganda Railway	B.S.S. Pea Pod type for 80 lb. rail, 6′6″ × 9″ wide at rail seat.	...
	B.S.S. Pea Pod type for 50 lb. rail, 6′3″ × 9″ wide at rail seat.	...
South African Railways & Harbours .	For 45 lb. rail. 6′3½″ × 9″	Type 4.
	For 60 lb. rail. 6′3½″ × 9¼″	»
	For 80-96 lb. rail. 6′9″ × 10″	»
Sudan Railways	Pea Pod type for 50 lb. rail. 6′1$^{5}/_{8}$″ × 9$^{5}/_{8}$″ (under rail) × 3$^{1}/_{8}$″	»
	Pea Pod type for 75 lb. rail. 6′3″ × 10″ (under rail) × 3$^{5}/_{8}$″	»
	Clip & bolt type for 75 lb. rail. 6′4¾″ × 10″ × 3$^{5}/_{16}$″	»

(Questions Nos. A 31, 32 & 36). (Continued.)

No. 31.		*Question No. 32.*					*Question No. 36.*	
(c)	*(d)*	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(a)*	*(b)*
180 to 245 lb. with chairs.	79 % 16 % 1½ % 1¾ % 1¾ %	No.	Yes.	Yes.	No bolts used.	...	...	100 %
180 to 245 lb. with chairs.	24 % 31 % 4½ % 4½ % 4 % B.H. & 8 % F.B. 24 %	No.	Yes.	Yes.	Yes in case of Tees Side sleepers.	No evidence.	11 %	89 %
180 to 245 lb. with chairs.	62½ % 37 % ½ %	No.	Yes.	Yes.	No bolts used.	...	...	100 %
...	...	...	...	...	...	...	...	...
132 lb.	...	Clip & 7/8" diam. bolt.	No.	No.	Yes.	No.	100 %	...
75 lb.	...	Clip & ¾" diam. bolt. (Rect. hole in sleepers).	...	...	...	...	...	...
75 lb.	7 %	T. bolt ¾" diam.	No.	No.	Yes.	No.	100 %	...
88 lb. 135 lb. without fittings.	42 % 51 %	Do. T. bolt 7/8" diam.						
36 kgr.	Present standard.	No — steel key used.	No.	No.	...	No.	100 %	...
...								
...	Small quantity. About to lay 100 000	Yes.						

TABLE No. 11.

Name of Railway.	Question (a)	Question (b)
Ceylon.		
Ceylon Government Railway.	Not used.	...
India.		
Great Indian Peninsula Railway (State Railway of India)	5′6″ gauge, 8′10½″ × ½″ thick.	...
	5′6″ gauge, 8′9½″ × 7/16″ thick.	...
	5′6″ gauge, 8′10½″ × 3/8″ thick.	...
	2′6″ gauge, 4′7″ × 9/32″ thick.	...
	2′6″ gauge, 4′7″ × 9/32″ thick.	...
North-Western Railway (State Railway of India	For 90 lb. rail. 5′6″ gauge, 8′9½″ × 12″ (under rail) & 8½″ at centre.	Type 4.
	For 75 lb. rail. 5′6″ gauge.	...
South Indian Railway.	90 lb. R.E.S.FF 4 keys 8′10½″ × 10″ × 33/64″ at rail seat & 13/32″ elsewhere.	Type 4.
	90 R-Key & distance pieces 8′10″ × 10″ to 8½″ × 7/16″	»
	90 R-Type 1 RS. 8′9½″ × 10 1/8 to 8½″ × ½″	»
	90 R-A & J Type 8′9″ × 11½″ × ¼″	»
	75 BS.FF. rails B.G. 8′6″ to 8′9″ × 9″ × 3/8″ at rail seat & ¼″ elsewhere.	»
	60 RBS reversible clips 6′0″ × 12¾″ × × 11/32″.	»
	60.R. Four keys 6′1½″ × 8 7/8″ × 21/64″	Type 4.
	60.R. Dist. piece & Keys 6′1½″ × 8¾″ × 21/64″	»
	60.R.B.S. Duplex at joints 6′0″ × 12¾″ × 11/32″	»
	50.R.B.S. Duplex at joints 6′1½″ × 11 7/8″ × 15/16″	»
	50.R.B.S. Dist. & key 6′1½″ × 8 3/8″ × 11/32″	»
	50.R.B.S. Loose steel jaws 6′0″ × 8½″ × 11/32″	»
Iraq.		
Iraqi State Railways	4′8½″ gauge. 8′6″ × 5″ flat × 3 15/32″	...
	Metre gauge. 6′0″ × 4″ flat × 3 3/16″	...
New Zealand.		
New Zealand Government Railways . .	Not used.	...

(Questions Nos. A 31, 32 & 36). (Continued.)

No. 31.		*Question No. 32.*					*Question No. 36.*	
(c)	*(d)*	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(a)*	*(b)*
...	...	...	...	...	...	...	...	...
168 lb. 153 lb. 133 lb. 43½ lb. 40 lb.	12 % 6 % 5 % 72 % 5 %	No.	...	No.	...	...	100 %	...
171 lb. 158.5 lb. (No plates or chairs used).	60 % with Mills Jaws & 40 % with pressed up lugs.	No — steel keys used.	No.	Yes in pressed up lug. type.	No bolts used.	...	100 %	...
168 lb.	Not available.	No bolts used.	A base plate is fixed in rare type.	Yes, in most types.	Yes.	Yes but negligible. Ballast is kept well drained.	100 %	...
153 lb.	...	»						
171 lb.	...	»						
135 lb.	...	¾" bolt $^{13}/_{16}$" hole.						
102 lb.	...	No bolts used.						
127.5 lb.	...	»						
76 lb.	...	No bolts used.	...	...	...	...	...	...
»	...	»	...	...	...	...	...	...
127.5 lb.	...	»	...	...	...	...	...	...
106 lb.	...	»	...	...	...	...	...	...
74.3 lb.	...	»	...	...	...	...	...	...
73.14 lb. Excluding fittings.	...	»	...	...	...	...	...	...
172.68 lb.	...	$^{7}/_{8}$" bolts $^{31}/_{32}$" holes.	...	No.	Yes.	No.	100 %	...
72.41 lb.	...	$^{7}/_{8}$" bolts $^{15}/_{16}$" holes.	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

TABLE No. 12

Name of Railway.	*Question* (a)	(b)	(c)	(d)	(e)	(f)
Argentine.						
Buenos Ayres Great Southern Railway	No.	No.	...	...	No.	...
Buenos Ayres & Pacific Rly.	No.	No.	...	...	No.	...
Buenos Ayres Western Railway	No.	No.	...	...	No.	...
Central Argentine Railway.	No.	No.	...	...	No.	
Buenos Ayres Midland . . .	No.	No.	...	...	No.	
Entre Rios & Argentine North-Eastern FF.CC.E.R. . . .	No.	No.	...	...	No.	..
Entre Rios & Argentine North-Eastern F.C.N.E.A. . . .	No.	No.	...	...	No.	.
Egypt.						
Chemins de fer de l'Etat . .	No.	No.	...	...	No.	...
United States of America.						
Baltimore & Ohio Railroad. .	No.	No.	...	...	No.	...
Bessemer & Lake Erie Railroad	No.	No.	...	...	No.	...
Great Britain.						
Great Western Railway . . .	No.	Yes.	8′6″ × 10″ × 6″ ($5\frac{1}{4}$″ at centre).	480 lb.	Yes.	Contractors
London Midland & Scottish Railway	No.	Yes.	Mostly 8′6″ × 10″ × $6\frac{1}{2}$″ ($5\frac{1}{4}$″ at centre) Experimental 7′6″ × 10″ × $5^{3}/_{8}$″ to 8′3″ × 10″ × 8″.	480 lb.	Yes.	Do.
London & North-Eastern Rly.	No.	Yes.	8′6″ × 10″ × $6\frac{1}{2}$″ 8′3″ × 11″ × 6″	500 lb. 450 lb.	Yes.	Do.

(Questions Nos. A 28 & 39).

No. 38.							*Question No. 39.*	
(g)	*(h)* (I)	*(h)* (II)	*(j)*	*(k)*	*(l)*	*(m)*	*(a)*	*(b)*
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
98 % pre-stressed.	No.	Yes in Cats. 3 & 4.	Steel tie bar at joints & every 3rd. pair of blocks.	...	2′0″ × 1′6″ × $5\frac{1}{4}$″	168 lb. without chair.	B.H.	Through bolts & chairs.
66 % pre-stressed at present. 100 % in future.	No.	...	...	...	...	...	B.H.	Do.
Variety tried, pre-stressed most satis-factory.	Yes in Cat. 4.	Yes in Cats. 3 & 4.	For certain re-inforced types.	Cat. 3 alte. sleepers. Cat. 4 exery 3rd. sleeper.	2′2″ × 1′0″ × 6″ & 1′10″ × 1′2″ × 6″	150 lb. without chair.	B.H.	Chairs with through bolts or cast in chair screws.

TABLE No. 12

Name of Railway.	*Question* (a)	(b)	(c)	(d)	(e)	(f)
Southern Railway	No.	Yes.	8′0″ to 8′6″ × 10½″ × 6″ Running Lines. 7′6″ × 10″ × 5³/₈″ Sidings.	510 & 540 lb. 390 lb.	Yes.	Contractors.
London Passenger Transport Board	No.	No.	...	...	No.	...
Africa.						
Kenya & Uganda Railway	No.	No.	...	...	No.	...
South African Railways & Harbours	No.	No.	...	...	Some on order.	...
Sudan Railways	No.	Experimental.	Various.	...	About to try out.	Own manufacture so far.
Ceylon.						
Ceylon Government Railway	No.	No.	...	...	No.	...
India.						
Great Indian Peninsula Railway (State Rly. of India)	No.	No.	...	...	No.	...
North-Western Railway (State Railway of India)	No.	No.	...	...	No.	...
South Indian Railway	No.	Yes.	Rail seat. Mid. Sect.		No.	Own manufacture.
			Metre gauge. Class A. 5′9″ & 5′5″ × 8″ & 6″ to 6½″ & 4½″ × 5¼″	190 lb.		
			Metre gauge. Class B. 5′5″ & 5′5″ × 9″ & 7″ to 7″ & 5″ × 5½″	225 lb.		
			5′6″ gauge. Class A. 9′0″ & 8′8″ × 10″ & 8″ to 7″ & 5″ × 5¾″	410 lb.		
			5′6″ gauge. Class B. 9′0″ & 8′8″ × 11″ & 9″ to 7″ & 5″ × 6″	470 lb.		
Iraq.						
Iraqi State Railways	No.	No.	...	...	No.	...
New Zealand.						
New Zealand Government Rlys.	No.	No.	...	...	No.	...

(*Questions Nos. A 28 & 39*). (Continued.)

No. 38.							*Question No. 39.*	
(g)	*(h)* (I)	*(h)* (II)	*(j)*	*(k)*	*(l)*	*(m)*	*(a)*	*(b)*
50 % Running line type. 50 % Siding type. 100 % prestressed in future.	Yes in Cat. 4.	Yes in Cat. 4.	No.	Alte. on sharp curves, otherwise every 3rd. sleeper.	2′0″ × 1′3″ × 5½″	130 lb. without chair.	B.H.	Chairs with through bolts or spikes & treenails.
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	Yes.	No.	Joint and every 3rd. sleeper are through wood or steel. Aternative tie bar connected to rails, between blocks.	1′11″ × 1′1″ × 5½″	126 lb. without sole-plates.	F.B.	Bolt & coach screws in wire spiral in blocks.
...	No	Yes.	Yes, Flat steel bar 3¼″ × 3/8″	...	2′0″ × 1′0″ × 7½″ (5½″ at edges).	175 lb.	F.B.	U Bolts.
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...
Only recently introduced.	No.	Yes.	No.	Alte. Blocks not used at joints.	Metre gauge 21″ × 10″ × 5″. 5′6″ gauge 25″ × 14½″ × 6″	90 lb. 180 lb.	F.B. mostly. Small length of B.H. has been tried.	Clips and bolts.
...	No.	No.	...	...	...	...	...	...
...	No.	No.	...	...	...	...	...	...

Name of Railway.	*Question No. 1.*			
	(a)	*(b)*	*(c)*	*(d)*
Argentine.				
Buenos Ayres Great Southern Rly.	Yes for lifts.	Yes on local sections.	Yes.	Fairly general for day to day maintenance.
Buenos Ayres & Pacific Railway . .	No.	Two — reconditioning gangs 90 men each pack 10 000 timber sleepers a month with pneumatic beaters.	Yes.	All shovel packed except for *(b)*.
Buenos Ayres Western Railway . .	Yes for lifts.	Yes on local sections.	Yes.	Fairly general for day to day maintenance.
Central Argentine Railway	Yes for earth ballasted track.	...	Almost universal.	Where tracks are stone ballasted.
Buenos Ayres Midland.	No.	No.	Yes.	None.
Entre Rios & Argentine North-Eastern FF.CC.E.R.	Yes.	No.	Yes.	For maintenance works. Not on heavy lifts.
Entre Rios & Argentine North-Eastern F.C.N.E.A.	Do.	Do.	Do.	Do.
Egypt.				
Chemins de fer de l'Etat	Yes.	Under trial.	Yes.	10 mm.
United States of America.				
Baltimore & Ohio Railroad	Yes.	Yes.	Yes.	Tamping down to refusal.
Bessemer & Lake Erie Railroad . .	Yes for spot surfacing.	Pneumatic for reconditioning track.	Shovels for under ballast.	None.
Great Britain.				
Great Western Railway	Yes.	Yes experimentally.	Yes.	40 %.
London Midland & Scottish Railway	Yes.	Yes to limited extend.	Yes.	Standard practice.

(*Questions Nos. B 1, 5, 7 & 10).*

	Question No. 5.		*Question No. 7.*	*Question No. 10.*
(e)	*(a)*	*(b)*		
100 cm. each side of rail (?)	Varies with traffic and location.	...	Underside of rail head.	« Spot » until rerailing necessary.
50 cm. each side of rail.	Varies with age traffic ballast and weather.	Not governed.	Level with top.	« Spot » until rerailing necessary.
100 cm. each side of rail (?)	Varies with traffic and location.	...	Underside of rail head.	« Spot » until rerailing necessary.
0.45 m. each side of rail.	...	...	To railhead with earth ballast & top of sleeper with stone.	General overhaul up to 15 %.
Practically 50 % from each end.	...	...	Clinker to top of sleeper, other ballast, box in rails.	100 % at rail joint, life is now much prolonged.
Into thirds.	Approx : 9 mths. Varies with formation, etc.	No difference experienced.	Timber sleepers on stone or gravel, sleepers covered. Earth ballast fully boxed in.	Not on Main Lines, but done on Branch Lines.
Do.	Do.	Do.	Do.	Do.
Under rails only.	Approx : every month according to condition.	To large extent.	Level with top.	Complete renewal when percentage of scrap sleepers is more than 50 %. Spot sleepered when percentage is less.
1'8" each side of rail.	Depends on traffic and formation.	*Stone Ballast.* Pneumatic tampers used for out of face working and hand tampers for spot work. *Gravel & Soft Ballast.* Shovel tamping or trowel.	$\frac{1}{2}$" below top.	Depends on traffic and formation.
12" inside rail to end of sleeper.	5 to 7 years for complete reconditioning.	*Stone Ballast.* power tamp. *Cinder Ballast.* shovel.	1" to 2" below top.	All renewals done by spotting.
15" each side of rail.	Depends on traffic and formation.	Measured packing and beater packing unsuitable on soft formation.	Level with top.	Only where necessary to replace defective sleepers.
15" each side of rail.	Depends on traffic and formation.	Measured packing and beater packing unsuitable on soft formation.	1" below top.	Only where necessary to replace defective sleepers in maintenance.

Name of Railway.	*Question No. 1.*			
	(a)	*(b)*	*(c)*	*(d)*
London & North-Eastern Railway. .	Yes.	Yes, both to limited extend.	Yes.	10 % (increasing).
Southern Railway	Yes. Lower edges of sleepers are damaged but there is no evidence of reduced life.	Yes to limited extend.	Yes.	65 % (increasing).
London Passenger Transport Board .	Yes.	Only specially.	Yes.	Widely used.
Africa.				
Kenya & Uganda Railway	No timber sleepers used.			...
South African Railways & Harbours	Mostly hand beaten.	No.	Limited extent.	Yes (increasingly).
Sudan Railways	Yes.	No.	No.	No.
Ceylon.				
Ceylon Government Railways . . .	Yes.	No.	No.	...
India.				
Great Indian Peninsula Railway (State Railway of India)	Yes.	No.	No.	...
North-Western Railway (State Railway of India)	Yes.	No.	No.	...
South Indian Railway	Yes.	No.	No.	...
Iraq.				
Iraqi State Railways	Yes.	No.	No.	...
New Zealand.				
New Zealand Government Railways .	Yes with certain ballast.	Pneumatic by Relayers.	Yes.	Not done.

(Questions Nos. B 1, 5, 7 & 10). (Continued.)

	Question No. 5.		*Question No. 7.*	*Question No. 10.*
(e)	*(a)*	*(b)*		
15″ each side of rail.	Depends on traffic and formation.	Measured packing and beater packing unsuitable on soft formation.	1″ below top.	Only where necessary to replace defective sleepers. The replacement sleepers are serviceable grades.
15″ each side of rail.	Depends on traffic and formation.	Measured packing and beater packing unsuitable on soft formation.	Level with top.	Only where necessary to replace defective sleepers in maintenance.
15″ each side of rail.	Depends on traffic and formation.	Measured packing and beater packing unsuitable on soft formation.	Level with top.	15 % of sleepers per annum used for spot work.
...	...	...	Level with top.	...
Under rail seat.	Depends on weather & traffic.	Soft formation require more attention.	Level with top.	Spot sleepering on timber sleepers sections done since 1938.
15″ each side of rail.	Minimum of 3 lifts per year.	Beater packing most suitable on ballast (earth or sand).	2″ above top.	To keep track up to standard in the few years prior to complete renewal.
12″ each side of rail.	Half yearly.	...	Level with top.	Spot sleepered only during the War.
3′0″ from the ends.	Depends on formation.	Very considerably.	Level.	As majority of road is on metal sleepers spotting is followed.
16½″ outside rail to 20½″ inside.	Once a year.	Only hand packing done.	Level with top.	Not done.
5′6″ gauge. 1′6″ each side rail. *Metre gauge.* 1′0″ each side of rail.	Cats. 1 & 2 lines. 20 to 25 days.	Governed by type of sleeper used.	½″ below bottom of rail.	10 % renewed by spotting.
Under rail seats.	Normally one per year.	...	*Stone ballast.* Level with top. *Earth.* 2″ above top.	Very limited.
12″ inside rail to end of sleeper outside.	Depends on traffic and formation.	Type of ballast mainly dictates packing.	2″ above top.	20 % renewed by spotting.

APPEN

TABLE No. 14

First Costs of Various Types of Sleepers used

'A' Timber — (1) Without Fastenings.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
Argentine.			£	*s.*	*d.*	£	*s.*	*d.*
Buenos Ayres Great Southern Railway.	Quebracho.	Stone.	...	11	7	...	11	2
Buenos Ayres & Pacific Railway . . .	»	»	...	12	11¾	...	10	11¾
Buenos Ayres Western Railway . . .	»	»	...	11	7	...	11	2
Central Argentine Railway	»	»	...	11	4	...	6	1¼
Buenos Ayres Midland.	»	Stone, Shell or Earth.	...	9	1¾	...	6	11½
Entre Rios & Argentine North-Eastern FF.CC.E.R.	Hard wood.	Earth.	...	11	4	...	6	7
Entre Rios & Argentine North-Eastern F.C.N.E.A.	»	Gravel.	...	10	3	...	5	11¾
Egypt.								
Chemins de fer de l'Etat	Jarrah.	»	1	10	1	...	7	0¼
United States of America.								
Baltimore & Ohio Railroad	All varieties.	All varieties.	...	10	8¾	...	7	3½
Bessemer & Lake Erie Railroad . . .	...	...						
Great Britain.								
Great Western Railway	Baltic Redwood.	Crushed Slag or Stone.	...	...	...	...	11	0
	Douglas Fir.	»	...	19	0			
London Midland & Scottish Railway .	Baltic Redwood.	...	...	...	...	...	7	2
	Douglas Fir.	...	...	17	3	...	5	2
	Maritime Pine.	...	...	...	...	...	6	4
	Western Hemlock.	...	...	17	3	...	4	8
	Home Grown.	...	...	15	6			
London & North-Eastern Railway . . .	Baltic Fir.	Crushed Slag or Stone.	...	...	...	...	9	2
	Douglas Fir.	»	...	17	5	...	8	1
	Scotch Fir.	»	...	13	3	...	7	5
	Oak.	»	...	19	9	...	...	...

DIX C

Question No. C 1).

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average first Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
...	1	$2\frac{1}{2}$	...	...	$7\frac{1}{4}$	...	12	$9\frac{1}{2}$	...	11	$9\frac{1}{4}$	...	...	...	...	...	...	...	
...	4	$10\frac{1}{2}$	...	2	$5\frac{1}{4}$	...	17	$10\frac{1}{4}$	...	13	5	30-40	...	...	6	...	...	$4\frac{1}{2}$	
...	1	$2\frac{1}{2}$	...	...	$7\frac{1}{4}$	...	12	$9\frac{1}{2}$	...	11	$9\frac{1}{4}$	...	...	...	...	...	...	...	
...	2	$5\frac{1}{4}$	...	1	$2\frac{1}{2}$	...	13	$9\frac{1}{4}$	...	7	$3\frac{3}{4}$	40	...	...	4	...	...	$2\frac{1}{4}$	
...	1	7	...	...	$11\frac{3}{4}$	...	10	$8\frac{3}{4}$	...	7	$11\frac{1}{4}$	40	...	...	$3\frac{1}{4}$	...	...	$2\frac{1}{4}$	
...	3	$9\frac{1}{4}$	...	2	3	...	15	$1\frac{1}{4}$	...	8	10	30	...	...	6	...	...	$3\frac{1}{2}$	
...	4	$10\frac{1}{2}$	...	3	$8\frac{1}{2}$	...	15	$1\frac{1}{2}$	...	9	$8\frac{1}{4}$	30	...	...	6	...	...	4	
...	...	$9\frac{3}{4}$	...	...	$7\frac{1}{4}$	1	10	$10\frac{3}{4}$	...	7	$7\frac{1}{2}$	20	...	1	$6\frac{1}{2}$	...	...	$4\frac{1}{2}$	
...	4	$2\frac{1}{2}$	...	2	$5\frac{3}{4}$	...	14	$11\frac{1}{4}$	...	9	$9\frac{1}{4}$	25	...	...	$7\frac{1}{4}$	...	...	$4\frac{3}{4}$	
...	...	...	...	2	1	...	...	...	...	11	3	25	...	...	...	...	...	$5\frac{1}{2}$	
...	4	1	...	2	1	1	1	6	...	10	2	17	...	1	$3\frac{1}{4}$	...	...	$7\frac{1}{4}$	
...	4	1	...	2	1	...	17	4	...	9	6	25	...	...	$8\frac{1}{4}$	...	...	$4\frac{1}{2}$	
...	4	1	...	...	...	1	3	10	...	...	...	18	...	1	4				

APPEN

TABLE No. 14

First Costs of Various Types of Sleepers used

'A' Timber — (1) Without Fastenings.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1*					
			Cost of Sleeper ready to put into Track.					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Southern Railway	Fir.	Granite.	1	0	3	...	12	0
London Passenger Transport Board	Softwood.	...	...	19	8	...	11	4
	Jarrah.	...	1	14	3	...	11	$3\frac{1}{2}$
Africa.								
Kenya & Uganda Railway	...	...	...	...	...	...	...	...
South African Railways & Harbours	Jarrah.	...	...	18	0	...	8	3
	Rhodesian Teak.	...	...	9	6	...	8	0
Sudan Railways	Softwood.	...	...	...	...	...	6	$7\frac{1}{2}$
	Hard wood.	...	...	13	$0\frac{1}{2}$	...	4	$0\frac{1}{4}$
Ceylon.								
Ceylon Government Railway	Satin (Local Hard wood)	$2\frac{1}{2}$" Metal.	1	1	0	...	7	6
India.								
Great Indian Peninsula Railway (State Railway of India)	Sal.	...	...	12	1	...	10	$9\frac{1}{2}$
North-Western Railway (State Railway of India)	Deodar (Creosoted).	...	...	13	$0\frac{1}{4}$	...	9	7
	Chir (Creosoted).	...	...	10	$11\frac{3}{4}$	...	8	0
	Fir (Creosoted).	...	...	9	9	...	...	...
South Indian Railway	Hard wood.	...	1	3	$7\frac{1}{2}$	...	8	$5\frac{1}{4}$
	»	...	...	11	$9\frac{3}{4}$	...	4	$1\frac{1}{2}$
Iraq.								
Iraqi State Railways	Jarrah.	...	...	...	...	...	4	9
	»	...	...	...	...	...	11	7
New Zealand.								
New Zealand Government Railways	Australian Eucalyptus.	Gravel.	...	15	6	...	7	6

DIX C

(Question No. C 1). (Continued.)

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	No timber sleepers used.
...	...	1¼	...	...	0¾	...	...	...	...	6	8¼	18-22	...	...	...	...	...	4	
...	...	1¼	...	...	0¾	...	13	1¾	...	4	1	20-24	...	...	7¼	...	...	2¼	
...	...	2	...	...	1	1	1	2	...	7	7	12	...	1	9	...	...	7½	
...	1	6	...	...	6¾	...	13	7	...	11	4¼	12	...	1	1½	...	...	11¼	
...	1	7¾	...	...	8	...	14	8	...	10	3	18	...	...	9¾	...	...	6¾	
...	1	7¾	...	...	8	...	12	7½	...	8	8	16	...	...	9½	...	...	6½	
...	1	7¾	...	...	8	...	11	4¾	...	...	...	11	...	1	0½				
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5′6″ Gauge. Metre gauge.
...	1	6	...	...	4	...	...	...	...	...	...	20	...	...	...	...	...	...	Metre gauge.
...	1	9	...	...	4½	...	...	...	...	...	...	20	...	...	...	...	...	...	4′8½″ gauge.
...	5	6	...	2	6	1	1	0	...	10	0	20	...	1	0½	...	...	6	

APPEN

TABLE No. 14

First Costs of Various Types of Sleepers used

'A' Timber — (2) With Fastenings — Chairs attached.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Argentine.								
Buenos Ayres Great Southern Railway.	Quebracho.	Stone.	1	18	5	...	17	$2\frac{1}{4}$
Buenos Ayres & Pacific Railway . . .	...	...						
Buenos Ayres Western Railway . . .	Quebracho.	Stone.	1	18	5	...	17	$2\frac{1}{4}$
Central Argentine Railway	»	»	...	16	$6\frac{1}{2}$	...	8	$10\frac{3}{4}$
Buenos Ayres Midland.	...	...						
Entre Rios & Argentine North-Eastern FF.CC.E.R.	...	...						
Entre Rios & Argentine North-Eastern F.C.N.E.A.	...	...						
Egypt.								
Chemins de fer de l'Etat	Jarrah.	Gravel.	1	16	$1\frac{1}{4}$	...	10	5
United States of America.								
Baltimore & Ohio Railroad	...	...						
Bessemer & Lake Erie Railroad . . .	...	...						
Great Britain.								
Great Western Railway	Baltic Redwood.	Crushed Slag or Stone.	...	...	...	...	18	0
	Douglas Fir.	»	1	11	6	...	...	...
London Midland & Scottish Railway .	Baltic Redwood.	...	...	...	...	...	14	6
	Douglas Fir.	...	1	9	10	...	12	6
	Maritime Pine.	...	...	...	...	...	13	8
	Western Hemlock.	...	1	9	10	...	12	0
	Home Grown.	...	1	8	0	...	...	...
London & North-Eastern Railway . . .	Baltic Fir.	Crushed	...	...	...	...	19	1
	Douglas Fir.	Slag	1	13	1	...	18	0
	Scotch Fir.	or Stone.	1	8	11	...	17	4
	Oak.	»	1	15	9	...	...	...

DIX C

Question No. C 1).

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
...	2	$2\frac{1}{4}$	...	1	1	2	0	$7\frac{1}{4}$	...	18	$3\frac{1}{2}$	...	...	...	...	...	...	...	
...	2	$2\frac{1}{4}$	...	1	1	2	0	$7\frac{1}{4}$	...	18	$3\frac{1}{2}$	...	...	...	...	...	...	...	
...	2	$5\frac{1}{4}$	...	1	$2\frac{1}{2}$	...	18	$11\frac{3}{4}$	...	10	$1\frac{1}{4}$	30	...	...	$7\frac{1}{2}$	...	...	4	
...	...	$9\frac{3}{4}$	...	...	$7\frac{1}{4}$	1	16	11	...	11	$0\frac{1}{4}$	20	...	1	10	...	...	$6\frac{1}{2}$	
...	...	...	...	4	0	...	...	...	1	2	0	$21\frac{1}{2}$	...	...	...	...	1	$1\frac{1}{4}$	
...	10	0	...	...	...	2	1	6	...	...	...	15	...	2	$9\frac{1}{4}$	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	
...	...	...	...	1	10	...	...	...	1	0	11	25	...	...	...	...	...	10	
...	3	5	...	1	10	1	16	6	...	19	10	17	...	2	$1\frac{3}{4}$	...	1	2	
...	3	5	...	1	10	1	12	4	...	19	2	25	...	1	$3\frac{1}{2}$	...	...	$9\frac{1}{4}$	
...	3	5	...	...	...	1	19	2	...	...	...	18	...	2	2	...	...	...	

APPEN

TABLE No. 14

First Costs of Various Types of Sleepers used

'A' Timber — (2) With Fastenings — Chairs attached.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Southern Railway	Fir.	Granite.	1	16	3	1	2	11
London Passenger Transport Board	Softwood.	...	1	17	5	1	1	1
	Jarrah.	...	2	9	8	1	1	0
Africa.								
Kenya & Uganda Railway	...	...	...	...	...	...	...	...
South African Railways & Harbours	Jarrah.	...	1	13	0	...	18	5
	Rhodesian Teak.	...	1	4	6	...	18	2
Sudan Railways	...	...						
Ceylon.								
Ceylon Government Railway.	...	...						
India.								
Great Indian Peninsula Railway (State Railway of India)	Sal.	...	1	5	6	...	18	11
North-Western Railway (State Railway of India)	Deodar (Creosoted).	...	1	2	8	...	14	$9\frac{1}{4}$
	Chir (Creosoted).	...	1	0	$7\frac{1}{4}$	...	13	2
	Fir (Creosoted).	...	...	19	$4\frac{3}{4}$	...	...	...
South Indian Railway.	Hard wood.	...	1	19	$6\frac{3}{4}$	...	...	...
	»	...	1	5	$9\frac{1}{2}$	...	...	...
Iraq.								
Iraqi State Railways	Jarrah.	...						
New Zealand.								
New Zealand Government Railways	Australian Eucalyptus.	Gravel.	...	...	...	...	...	...

DIX C

(Question No. C 1). (Continued.)

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	No timber sleepers used.
...	2	3	...	1	6	1	15	3	...	19	11	15	...	2	4¼	...	1	4	
...	2	3	...	1	6	1	6	9	...	19	8	10	...	2	8	...	1	11½	
...	1	6	...	...	6¾	1	7	0	...	19	5¾	12	...	2	3	...	1	7½	
...	1	7¾	...	...	8	1	4	3¾	...	15	5¼	18	...	1	4¼	...	...	10¼	
...	1	7¾	...	...	8	1	2	3	...	13	10	16	...	1	4¾	...	...	10½	
...	1	7¾	...	...	8	1	1	0½	...	...	...	11	...	1	11	...	...	...	
...	...	4½	...	...	...	1	19	11¼	...	...	...	...	...	...	...	...	...	...	5′6″ Gauge. Anti creep chairs.
...	...	3¼	...	...	...	1	6	0¾	...	...	...	...	...	...	...	...	...	...	Metre gauge. Anti creep chairs.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Chairs not used.

TABLE No. 14

First Costs of Various Types of Sleepers used

'A' Timber — (2) With Fastenings — Baseplates attached.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Argentine.								
Buenos Ayres Great Southern Railway.	Quebracho.	Stone.	...	...	...	...	16	5½
Buenos Ayres & Pacific Railway . . .								
Buenos Ayres Western Railway . . .								
Central Argentine Railway								
Buenos Ayres Midland.								
Entre Rios & Argentine North-Eastern FF.CC.E.R.								
Entre Rios & Argentine North-Eastern F.C.N.E.A.								
Egypt.								
Chemins de fer de l'Etat								
United States of America.								
Baltimore & Ohio Railroad	All varieties.	All varieties	...	12	11½	...	9	1
Bessemer & Lake Erie Railroad . . .	Red Oak — Cresd. with Tieplates.	Crushed Limestone.	...	17	4½	...	10	8
Great Britain.								
Great Western Railway								
London Midland & Scottish Railway .								
London & North-Eastern Railway . . .	Baltic Fir.	Crushed						
	Douglas Fir.	Slag	1	11	7	...	...	...
	Scotch Fir.	or Stone.	1	7	5	...	...	...
	Oak.	»	1	13	11	...	...	...
Southern Railway								
London Passenger Transport Board .. .								
Africa.								
Kenya & Uganda Railway	...	...	...	...	...	...	...	...
South African Railways & Harbours .	Jarrah.	...	1	6	0	...	10	1
	Rhodesian Teak.	...	...	17	6	...	9	10
Sudan Railways								
Ceylon.								
Ceylon Government Railway.								
India.								
Great Indian Peninsula Railway (State Railway of India)								
North-Western Railway (State Railway of India)								
South Indian Railway.	Hard wood.	...	1	18	2	...	12	0
	»	...	...	16	10½	...	5	4¼
Iraq.								
Iraqi State Railways								
New Zealand.								
New Zealand Government Railways . .	Australian Eucalyptus.	Gravel.	1	1	10	...	10	6

DIX C

Question No. C 1).

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1939			*1946*			*1939*			*1946*			*Years.*	*1946*			*1939*			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
...	5	$8\frac{3}{4}$	...	2	$10\frac{1}{2}$	...	...	...	...	19	4	50	...	...	...	...	...	$4\frac{3}{4}$	
..	4	$2\frac{1}{2}$	...	2	$5\frac{3}{4}$	...	17	2	...	11	$6\frac{3}{4}$	25	...	...	$8\frac{1}{4}$	...	...	$5\frac{1}{4}$	
...	3	$11\frac{1}{2}$	...	2	$5\frac{3}{4}$	1	1	4	...	13	$1\frac{3}{4}$	25	...	...	10	...	...	$6\frac{1}{4}$	
						1	15	0	...	...	...	17	...	2	$0\frac{3}{4}$	...	...	...	
...	3	5	...	...	...	1	10	10	...	...	...	25	...	1	$2\frac{3}{4}$	...	...	...	
...	3	5	...	...	...	1	17	4	...	...	...	18	...	2	1	...	...	...	
...	3	5	...	...	...														
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	No timber sl-epers used.
...	2	3	...	1	6	1	8	3	...	11	7	15	...	1	$10\frac{1}{2}$	...	...	$9\frac{1}{4}$	Soleplates attached.
...	2	3	...	1	6	...	19	9	...	11	4	10	...	1	$11\frac{3}{4}$	...	1	$1\frac{1}{2}$	
...																			
																			5′6″ Gauge.
		$3\frac{1}{4}$	...	...	$1\frac{1}{2}$	1	18	$5\frac{1}{4}$	...	12	$1\frac{3}{4}$	...	...	...	...	...	...	...	Metre gauge.
...		$2\frac{1}{4}$	...	...	1	...	17	$0\frac{3}{4}$	...	5	$5\frac{1}{4}$	...	...	...	...	...	...	...	
...																			
																		$7\frac{3}{4}$	
...	5	6	...	2	6	1	7	4	...	13	0	20	...	1	$4\frac{1}{2}$	...	...		

TABLE

First Costs of Various Types of Sleepers

'B' Steel — (1) Without Fastenings.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to into Track.*				
			1946			*1939*	
			£	*s.*	*d.*	£	*s.*
Argentine.							
Buenos Ayres Great Southern Railway.	...	...	...	..	...	...	...
Buenos Ayres & Pacific Railway . . .	...	Stone.	...	...	...	...	6
Buenos Ayres Western Railway . . .	...	...	...	...	...	...	...
Central Argentine Railway	...	...	...	...	...	...	...
Buenos Ayres Midland.	...	...	...	...	...	...	...
Entre Rios & Argentine North-Eastern FF.CC.E.R.	...	...	...	...	...	...	...
Entre Rios & Argentine North-Eastern F.C.N.E.A.	...	...	...	...	...	...	...
Egypt.							
Chemins de fer de l'Etat							
United States of America.							
Baltimore & Ohio Railroad							
Bessemer & Lake Erie Railroad . . .							
Great Britain.							
Great Western Railway	...	...	...	...	...	...	...
London Midland & Scottish Railway .	All Types.						
London & North-Eastern Railway . . .							
Southern Railway	...	...	...	...	...	...	...
London Passenger Transport Board .. .							
Africa.							
Kenya & Uganda Railway	80 lb Rail.	...	1	13	0	...	...
	50 lb. Rail.	...	1	0	0	...	...
South African Railways & Harbours .	80-96 lb. Rail.	...	1	6	0	...	10
	60 lb. Rail.	...	...	18	0	...	7
Sudan Railways	50 lb. Rail.	...	...	...	...	...	7
	75 lb. Rail.	...	...	...	...	...	10
Ceylon.							
Ceylon Government Railway.							
India.							
Great Indian Peninsula Railway (State Railway of India)	168 lb. Trough.	...	1	4	$3\frac{1}{2}$	...	10
North-Western Railway (State Railway of India)	Trough.	...	1	9	$8\frac{3}{4}$	...	16
South Indian Railway.	...	...	1	9	3	...	12
Iraq.	...	...	...	...	...	...	6
Iraqi State Railways	...	...	...	...	...	...	17
New Zealand.							
New Zealand Government Railways . .							

DIX C

Question No. C 1).

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	National Hardwood sleepers must be used by law.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	None used since 1936.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	None used in Fast or Principal Lines.
...	...	...	...	...	...	...	...	...	...	...	...	20-40	...	...	...	...	...	...	Including Fittings.
...	...	...	...	...	...	...	...	...	...	...	...	20-40	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	40							
...	...	...	...	...	...	...	...	...	...	...	...	40							
...	1	6	...	...	6¾	...	5	9½	...	11	5¼	35	...	...	8¾	...	...	4	
...	1	10½	...	...	9	1	11	7¼	...	16	11	45	...	...	8½	...	...	4½	
...	...	...	...	...	...	...	...	...	...	...	...	Not known.	...	...	...	...	...	...	5′6″ Gauge.
...	...	...	...	...	...	...	...	...	...	...	...	»	...	...	...	...	...	...	Metre gauge.
...	...	...	...	...	8	...	...	...	...	18	1	»	...	...	...	...	...	...	4′8½″ gauge.

APPEN

TABLE No. 14

First Costs of Various Types of Sleepers used

'B' Steel — (2) With Fastenings — Chairs attached.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Argentine.								
Buenos Ayres Great Southern Railway.								
Buenos Ayres & Pacific Railway . . .	...	Stone.	...	...	...	...	8	6½
Buenos Ayres Western Railway . . .	...	...	...	...	...	...	...	...
Central Argentine Railway	...	...	...	...	...	...	...	...
Buenos Ayres Midland.	...	...	...	...	...	...	...	...
Entre Rios & Argentine North-Eastern FF.CC.E.R.	...	...	...	...	...	...	...	...
Entre Rios & Argentine North-Eastern F.C.N.E.A.								
Egypt.								
Chemins de fer de l'Etat								
United States of America.								
Baltimore & Ohio Railroad								
Bessemer & Lake Erie Railroad . . .								
Great Britain.								
Great Western Railway	...	...	...	...	...	...	...	...
London Midland & Scottish Railway .	All types.	...	...	...	...	...	15	11
London & North-Eastern Railway . . .	Rolled Steel with fabricated chair — (All welded).	Granite.	1	7	0	...	17	7

DIX C

Question No. C 1).

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
...	4	10½	...	2	5¼	...	...	...	...	10	11¾	40	...	...	...	...	...	3¼	National Hardwood sleepers must be used by law.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Do.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	None used since 1936.
...	3	5	...	1	10	1	10	5	...	19	5	20	...	1	6¼	...	...	11¾	

APPEN

TABLE No. 14

First Costs of Various Types of Sleepers used

'B' Steel — (2) With Fastenings — Chairs attached.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Southern Railway	...	...	...	...	...	...	...	...
London Passenger Transport Board .. .								
Africa.								
Kenya & Uganda Railway								
South African Railways & Harbours .	80-96 lb.	...	1	8	8	...	11	11
	60 lb.	...	1	0	0	...	8	11
Sudan Railways	75 lb. (With clips & bolts).	...	1	0	0			
Ceylon.								
Ceylon Government Railway.								
India.								
Great Indian Peninsula Railway (State Railway of India)	168 lb. Troughs.	...	1	8	2	...	12	7½
North-Western Railway (State Railway of India)	Trough.	...	1	13	9	...	19	3
South Indian Railway.	...	...	1	11	6	...	12	9
							6	10¼
Iraq.								
Iraqi State Railways	Bolts & Clips.	...	...	...	...	1	3	2
New Zealand.								
New Zealand Government Railways . .								

DIX C

(Question No. C 1). (Continued.)

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			*Years.*	*1946*			*1939*			
£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	
...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	None used in Fast or Principal Lines.
...	2	3	...	1	6	1	10	11	...	13	5	30	...	1	$0\frac{1}{4}$	...	...	$5\frac{1}{2}$	(Chairs not attached). (T Bolts & Clips).
...	1	11	...	1	3	1	1	11	...	10	2	30	...	...	$8\frac{3}{4}$	...	...	4	
...	1	6	...	...	$6\frac{3}{4}$	1	9	8	...	13	$2\frac{1}{4}$	35	...	...	$10\frac{1}{4}$	...	...	$4\frac{1}{2}$	
...	1	$10\frac{1}{2}$	...	...	9	1	15	$7\frac{1}{2}$	1	0	0	45	...	...	$9\frac{1}{2}$	...	...	$5\frac{1}{2}$	
...	...	$2\frac{3}{4}$	...	...	1	1	11	$8\frac{3}{4}$	...	12	10	Not known.	...	...	...	...	...	...	4′8½″ gauge.
...	...	$1\frac{3}{4}$	...	...	$0\frac{3}{4}$	...	...	...	...	6	11	»	...	...	...	...	...	...	Metre gauge.
...	...	...	...	...	8	...	...	...	1	3	10	...	...	...	...	...	...	...	4′8½″ gauge.

TABLE No. 14

First Costs of Various Types of Sleepers used

'B' Steel — (2) With Fastenings — Baseplates attached.

Name of Railway.	*Variety of Timber.*	*Type of Ballast.*	*1* *Cost of Sleeper ready to put into Track.*					
			1946			*1939*		
			£	*s.*	*d.*	£	*s.*	*d.*
Great Britain.								
London & North-Eastern Railway . . .	Base Plate welded to sleeper. Set screw & clip.	Granite.	1	10	11	1	0	1
	Base Plate welded to sleeper. T bolt & clip.	»	1	11	11	1	0	9
'C' Concrete - (1) Without Fastenings.								
Great Britain.								
Great Western Railway	Prestressed.	Crushed slag or stone.	1	5	8			
London Midland & Scottish Railway. .	»	...	1	7	11½			
London & North-Eastern Railway . . .	Plain.	Granite.	1	13	0	...	...	...
	Prestressed.	»	1	8	1	...	...	...
Southern Railway								
London Passenger Transport Board . .								
Africa.								
South African Railways & Harbours. .	Blocks only. Per 2 blocks.	...	...	8	0	...	...	...
'C' Concrete - (2) With Fastenings - Chairs attached.								
Great Britain.								
Great Western Railway	Prestressed.	Crushed slag or stone.	2	0	0			
London Midland & Scottish Railway. .	»	»	2	0	9			
London & North-Eastern Railway . . .	Plain.	Granite.	2	4	10	...	...	...
	Prestressed.	»	1	19	10	...	...	...
Southern Railway	...	...	...	...	...	...	...	...
London Passenger Transport Board . .								
Africa.								
South African Railways & Harbours. .	Blocks only — ⅓ Cost of Ties.	...	1	6	0	...	...	...
'C' Concrete - (3) With Fastenings - Soleplates attached.								
South African Railways & Harbours. .	Blocks only ⅓ cost of Ties.	...	...	19	0	...	...	...

DIX C

Question No. C 1).

upon Fast or Principal Passenger Lines (per Sleeper)

2						3						4	5						6
Wages Cost of Laying in.						*Gross Cost.*						*Estimated Average First Life.*	*Average Cost per Sleeper per annum.*						*Remarks.*
1946			*1939*			*1946*			*1939*			Years.	*1946*			*1939*			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
	3	5		1	10	1	14	4	1	1	11	20	...	1	$8\frac{1}{2}$		1	$1\frac{1}{4}$	
...	3	5	...	1	10	1	15	4	1	2	7	20	...	1	$9\frac{1}{4}$	...	1	$1\frac{1}{2}$	
...	4	3	...	...	...	1	17	3	...	...	...	5	...	7	$5\frac{1}{2}$	...	...	...	Price high due to manufacture of special design in small quantity.
...	4	3	...	...	...	1	12	4	...	...	...	50	...		$7\frac{3}{4}$	...	...	...	Only small purchases for experimental purposes.
...	...	...	...	...	...	...	...	...	...	...	...	10							
...	3	10	...	...	...	2	8	8	...	...	...	5	...	9	$8\frac{3}{4}$	...	...	...	Only small purchases for experimental purposes.
...	3	10	...	...	...	2	3	8	...	...	...	50	...	...	$10\frac{1}{2}$	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Not used in Fast or Principal Lines.
...	2	3	...	...	...	1	8	3	...	...	...	10	...	2	10				
...	2	3	...	...	...	1	1	3	...	...	...	10	...	2	$1\frac{1}{2}$				

TABLE No. 15

Average percentage proportion of Serviceable life of re-used sleepers taken

Name of Railway.	*Timber Sleepers.*	
	Serviceable %	*Additional Life — Years.*
Argentine.		
Buenos Ayres Great Southern Railway	75	...
Buenos Ayres & Pacific Railway	75	...
Buenos Ayres Western Railway	75	...
Central Argentine Railway	35	...
Buenos Ayres Midland	...	...
Entre Rios & Argentine North-Eastern FF.CC.E.R.	...	...
Entre Rios & Argentine North-Eastern F.C.N.E.A.	...	...
Egypt.		
Chemins de fer de l'Etat	50	10
United States of America.		
Baltimore & Ohio Railroad	10	5-8
Bessemer & Lake Erie Railroad.	5	5-10
Great Britain.		
Great Western Railway	50	...
London Midland & Scottish Railway	40-60	20
London & North-Eastern Railway	Baltic 50	20
	Douglas Fir . . . —	...
	Scotch Fir 40	15
	Oak 50	15
Southern Railway	70	15
London Passenger Transport Board	40	10
Africa.		
Kenya & Uganda Railway	...	...
South African Railways & Harbours	Normally . . . . 30 During War . . . 10	Normally . . . . 10 During War . . . 5
Sudan Railways	...	...
Ceylon.		
Ceylon Government Railway	10	2
India.		
Great Indian Peninsula Railway (State Railway of India)	15	2-3
North-Western Railway (State Railway of India)	25-30	5-10
South Indian Railway	....	4
Iraq.		
Iraqi State Railways	...	...
New Zealand.		
New Zealand Government Railways	50	10

(Question No. C 2).

& Scrap Sleepers & average additional

from fast or principal lines.

Steel Sleepers.		*Concrete Sleepers.*		*Remarks.*
Serviceable %	*Additional Life — Years.*	*Serviceable %*	*Additional Life — Years.*	
20	...	...	...	
...	...	...	...	100 % Scrap from « spotting ».
20	...	...	...	
...	...	...	...	
...	...	...	...	
...	...	...	...	No wholesale renewal carried out.
...	...	...	...	
50	20	...	...	
...	...	...	...	
...	...	...	...	
50	...	...	...	
...	...	...	...	
75	20	...	...	
...	...	...	...	
...	...	...	...	
...	10-20	...	...	No Timber or Concrete sleepers used.
95	5	...	...	
...	...	...	...	
...	...	...	...	
30	5-7	...	...	
15-20	15-20	5	5-10	
...	...	...	...	
...	...	...	...	
...	...	...	...	

TABLE No. 16

Cost (per sleeper) of preservative processes

Name of Railway.	*Timber Sleepers.*									
	Variety of Timber.	*Preservation.*			*Cost per Sleeper.*					
		Process.	*Solution used.*	*Quantity absorbed per cu. ft.*	*1946*			*1939*		
				Gallons.	£	*s.*	*d.*	£	*s.*	*d.*
Argentine.										
Buenos Ayres Great Southern Railway										
Buenos Ayres & Pacific Rly.										
Buenos Ayres Western Railway										
Central Argentine Railway.										
Buenos Ayres Midland										
Entre Rios & Argentine North-Eastern FF.CC.E.R.										
Entre Rios & Argentine North-Eastern F.C.N.E.A.										
Egypt.										
Chemins de fer de l'Etat										
United States of America.										
Baltimore & Ohio Railroad.	All varieties.	Rueping. (Empty cell with initial air).	80/20 Creosote Coal Tar.	0.193	...	2	$4\frac{1}{2}$	...	3	$2\frac{3}{4}$
Bessemer & Lake Erie Railroad	Red Oak.	»	»	0.165	...	5	$5\frac{1}{2}$	...	3	$5\frac{3}{4}$
Great Britain.										
Great Western Railway	Baltic Redwood.	Full-cell.	Creosote	1.000	...	...	...	...	1	3
	Douglas Fir.	»	»	0.666	...	1	3			
	Maritime Pine.	»	»	...						
	Scotch Fir.	»	»	...						
	Oak.	»	»	0.500	...	1	3			
London Midland & Scottish Railway	Baltic Redwood.	»	»	1.000	...	...	...	...	...	$9\frac{1}{4}$
	Douglas Fir.	»	»	0.666	...	...	9	...	...	6
	Maritime Pine.	»	»	0.500	...	...	...	...	...	$9\frac{1}{4}$
	Scotch Fir.	»	»	0.500	...	1	$5\frac{1}{4}$	...	...	$8\frac{1}{2}$

(Question No. C 3).

used on Timber, Steel or Concrete Sleepers.

Steel Sleepers.							*Concrete Sleepers.*							
Preservation Process.	*Cost per Sleeper.*						*Preservation Process.*	*Cost per Sleeper.*						*Remarks.*
	1946			*1939*				*1946*			*1939*			
	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	
Were originally coated but no information available.														

TABLE No. 1

Cost (per sleeper) of preservative proces

Name of Railway.	*Timber Sleepers.*									
	Variety of Timber.	*Preservation.*			*Cost per Sleeper.*					
		Process.	*Solution used.*	*Quantity absorbed per cu. ft.*	*1946*			*1939*		
				Gallons.	£	*s.*	*d.*	£	*s.*	*d*
London & North-Eastern Rly.	Baltic Redwood.	Full-cell.	Creosote.	0.966	...	...	...	...	1	
	Douglas Fir.	»	»	0.500	...	1	5	...	...	9
	Maritime Pine.	»	»	...						
	Scotch Fir.	»	»	0.833	...	1	11	...	1	
	Oak.	»	»	0.400	...	1	3	...	...	...
Southern Railway	Baltic Redwood.	»	»	1.000	...	...	...	...	2	
	Douglas Fir.	»	»	0.750	...	2	8			
London Passenger Transport Board	Douglas Fir.	Full-cell.	Creosote.	0.750	...	3	10			
Africa.										
Kenya & Uganda Railway . .	...	...	...	...	...	...	...	...	...	...
South African Railways & Harbours	...	...	...	...	...	...	...	...	...	...
Sudan Railways.	Hard & Soft.	Full-cell.	50/50 Creosote & Fuel Oil.	0.201	Including Adzing and Boring.					
				...	...	2	0	...	1	
Ceylon.										
Ceylon Government Railway .	...									
India.										
Great Indian Peninsula Railway (State Rly. of India) .										
North-Western Railway (State Railway of India)	Fir & Kail.	Full-cell.	40/60 Creosote & Fuel Oil.	...	...	1	9½	...	...	
	Deodar Chir.	» Rueping.		...	...	1	5	...	...	
South Indian Railway . . .				...	...	1	11¾	...	1	
Iraq.										
Iraqi State Railways										
New Zealand.										
New Zealand Government Rlys.										

(Question No. C 3). (Continued.)

used on Timber, Steel or Concrete Sleepers.

Steel Sleepers.							*Concrete Sleepers.*							
Preservation Process.	*Cost per Sleeper.*						*Preservation Process.*	*Cost per Sleeper.*						*Remarks.*
	1946			*1939*				*1946*			*1939*			
	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	
Coated with Hot Gas Tar — included in Purchase Price.														
»														
»														
Coated with Hot Bituminous Compound by Makers.	...	...	...	...	...	...	...	...	...	...	...	...	...	No timber or concrete sleepers used.
Dr. Angus Smith solution by makers.														
Do.														
Coal Tarred.														

TABLE No. 17

Cost (per sleeper) of Timber Sleepers

Name of Railway.	*Adzing.*						
	1946			*1939*			
	£	*s.*	*d.*	£	*s.*	*d.*	
Argentine.							
Buenos Ayres Great Southern Railway	...	...	...	...	...	...	...
Buenos Ayres & Pacific Railway							
Buenos Ayres Western Railway	...	...	...	...	...	...	...
Central Argentine Railway							
Buenos Ayres Midland							
Entre Rios & Argentine North-Eastern FF. CC.E.R.							
Entre Rios & Argentine North-Eastern F.C. N.E.A.							
Egypt.							
Chemins de fer de l'Etat							
United States of America.							
Baltimore & Ohio Railroad							
Bessemer & Lake Erie Railroad							
Great Britain.							
			Including boring.				
Great Western Railway	...	...	1	...	...	$0\frac{1}{2}$	...
London Midland & Scottish Railway	...	...	$3\frac{1}{2}$	...	...	$1\frac{1}{4}$	...
			Including boring.				
London & North-Eastern Railway	...	...	...	...	...	...	...
			Including boring.				
Southern Railway	...	...	$1\frac{3}{4}$	...	...	$1\frac{1}{4}$	...
London Passenger Transport Board	...	...	...	...	...	...	...
Africa.							
Kenya & Uganda Railway	...	...	...	...	...	...	...
South African Railways & Harbours							
Sudan Railways	...	...	...	...	...	...	...
Ceylon.							
Ceylon Government Railway							
India.							
Great Indian Peninsula Railway (State Railway of India)	...	...	...	...	...	...	...
North-Western Railway (State Rly. of India)	...	...	$1\frac{1}{2}$	...	...	$0\frac{1}{2}$	
South Indian Railway							
Iraq.							
Iraqi State Railway							
New Zealand.							
New Zealand Government Railways							

(Question No. C 4).

chaired by machine methods at Depots.

Boring.							Chairing.						Remarks.
1946			1939				1946			1939			
£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	
...	...	...	...	...	...	...	...	...	...	...	...	...	Adzing and Boring one operation.
...	...	...	...	...	...	...	...	...	...	...	...	...	Adzing and Boring one operation.
Including Adzing.													
...	...	1	...	...	$0\frac{1}{2}$	...	...	...	4	...	...	2	
...	...	$3\frac{1}{2}$	...	...	$1\frac{1}{4}$	...	...	...	$6\frac{1}{2}$	...	...	$2\frac{3}{4}$	
Including Adzing.													
...	...	2	...	...	1	...	...	...	8	...	...	3	
Including Adzing.													
...	...	$1\frac{3}{4}$	...	...	$1\frac{1}{4}$	...	...	...	7	...	...	$5\frac{1}{4}$	
...	...	...	...	...	...	...	...	...	...	...	...	...	Adzing, Boring and Chairing. 1946 —/8d. 1939 —/5d.
...	...	...	...	...	...	...	...	...	...	...	...	...	No Timber Sleepers used.
...	...	...	...	...	...	...	...	...	...	...	...	...	Adzing, Boring and Creosoting. 1946 2/— 1939 1/—
...	...	...	...	...	...	...	...	...	...	...	...	...	Adzing, Boring and Chairing. 1946 —/9d. 1939 —/$5\frac{1}{2}$d.

Summary of Cost of Packing

Name of Railway.	*Shovel Packing.*						
	1946			*1939*			
(1) With Timber Sleepers.	£	*s.*	*d.*	£	*s.*	*d.*	
Argentine.							
Buenos Ayres & Pacific Railway	68	13	11	34	6	11	...
Central Argentine Railway	46	6	4	22	1	6	...
			Relative Cost.				
Buenos Ayres Midland.		1.6			1.0		
Egypt.							
Chemins de fer de l'Etat	...	...	...	...	...	...	...
United States of America.							
Baltimore & Ohio Railroad	186	2	1	124	1	5	...
Bessemer & Lake Erie Railroad	...	...	...	...	...	...	...
Great Britain.							
London & North-Eastern Railway	42	13	7	25	12	2	...
Africa.							
South African Railways & Harbours	...	...	...	...	...	...	...
Sudan Railways	...	...	...	...	...	...	...
Ceylon.							
Ceylon Government Railway	...	...	...	...	...	...	...
India.							
Great Indian Peninsula Railway (State Railway of India)	...	...	...	...	...	...	...
North-Western Railway (State Rly. of India)	...	...	...	...	...	...	...
South Indian Railway	...	...	...	...	...	...	...
(2) With Steel Sleepers.							
Argentine.							
Buenos Ayres & Pacific Railway	...	...	...	...	...	...	...
Buenos Ayres Midland.			*Relative Cost.*				
		1.6			1.0		
Africa.							
Kenya & Uganda Railway	...	...	...	...	...	...	...
South African Railways & Harbours	...	...	...	...	...	...	...
Sudan Railways	...	...	...	...	...	...	...
India.							
Great Indian Peninsula Railway (State Railway of India)	...	...	...	...	...	...	...
North-Western Railway (State Rly. of India)	...	...	...	...	...	...	...
South Indian Railway	...	...	...	...	...	...	...
(3) With Concrete Sleepers.							
Africa.							
South African Railways & Harbours	...	...	...	...	...	...	...

(Question No. C 5).

or Tamping Sleepers (per mile).

Hand Beaters.							*Pneumatic or Electric Beaters.*						*Remarks.*
1946			*1939*				*1946*			*1939*			
£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	
...						...	98	2	7	44	3	2	
117	9	3	55	18	9								
24	4	3											
372	4	2	248	2	10	...	223	6	6	148	17	8	
...	...	...	...	...	...	...	245	13	2	136	9	6	
82	10	0	45	16	7	...	45	16	7	27	10	0	Costs result of experimental tests. Opinion — Mechanical Packing lasts twice as long as Hand Beater Packing.
270	0	0	180	0	0								
4	0	9	3	1	5								
6	0	0	3	0	0								
33	15	0	22	10	0								
99	15	0	39	18	0								
7	10	0	3	0	0								
107	18	10	53	19	6								
9	0	0	6	0	0								
270	0	0	180	0	0								
4	0	9	3	1	5								
33	15	0	22	10	0								
93	15	0	37	10	0								
9	15	0	3	18	0								
200	0	0	150	0	0								

[621 .438]

Gas Turbines for Railway Traction.

An outline of the thermodynamic features of gas turbines with particular reference to locomotive application.

(*The Railway Gazette, November 22, 1946.*)

The development of gas turbines in Great Britain has been associated almost exclusively with aviation, but there are many other fields of application for the gas turbine, notably in the generation of electric power and for use as a prime mover in a locomotive. It is principally in Switzerland that combustion turbines have been developed in recent years for this type of heavy engineering application.

It is simply a question of substituting a different prime mover for generating the electric power.

It is not yet possible to assess accurately the relative merits of the gas turbine for railway traction as compared with the diesel engine, in particular as regards availability, because gas turbines are still in the early stages of development. However, one can at least investigate the possible range of thermal

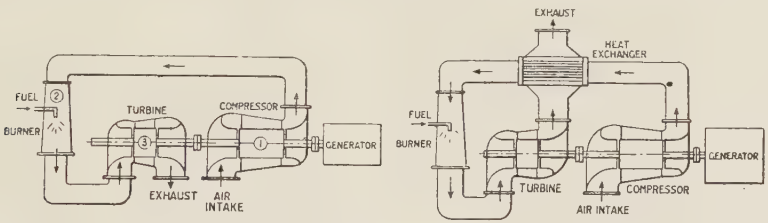


Fig. 1*a* (left) and 1*b* (right). — Alternative arrangements of open-circuit gas turbine.

With the conclusion of the war, however, the concentration of research and design facilities in Great Britain on aircraft turbines presumably will be reduced to some extent, and there is every reason to suppose that manufacturers will turn their attention to the construction of gas turbines for power generation.

For railway traction the gas turbine is likely to find its application as a rival to the diesel engine in the higher power ranges. As with diesel power, electric transmission will be essential, and, in fact, the electrical features of the gas turbine locomotive will resemble closely those of the diesel-electric locomotive. efficiency of gas turbine locomotives, and thus form some idea of their operating costs.

Gas turbines are referred to usually as being of either the « open-circuit » or « closed-circuit » types. The essential difference is that with the open-circuit turbine, internal combustion is used, that is, the fuel is burnt in the air stream and the products of combustion pass through the turbine; whereas with the closed-circuit turbine, external combustion is used and the exhaust air from the turbine is cooled and then returned to the compressor.

There are actually a number of different cycles which may be used, and

some of these are illustrated by diagrams in Fig. 1 (a to d). The most simple layout is the open-circuit arrangement shown in Fig. 1a, and the working cycle in this case is essentially Joule's constant-pressure air cycle. A development of this layout, with the addition of a heat exchanger, is shown in Fig. 1b; the exhaust gases from the turbine are used to pre-heat the air before entry to the burner, thus achieving an increase in logical development from the multi-stage open-circuit turbine with heat exchanger shown in Fig. 1c. By substituting externally-fired heaters in place of the burners, and by passing the exhaust air from the turbine through a cooler and then returning it to the compressor inlet, an entirely closed cycle is achieved. This is, in effect, a modern approach to the reversible cycle employing a regenerator which was first suggested by

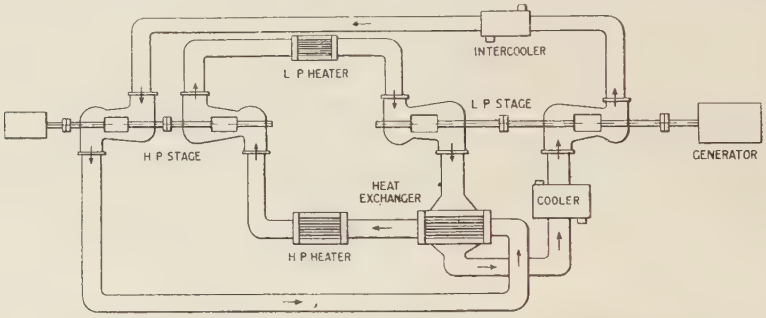


Fig. 1c. — Open-circuit two-stage turbine with intercooler.

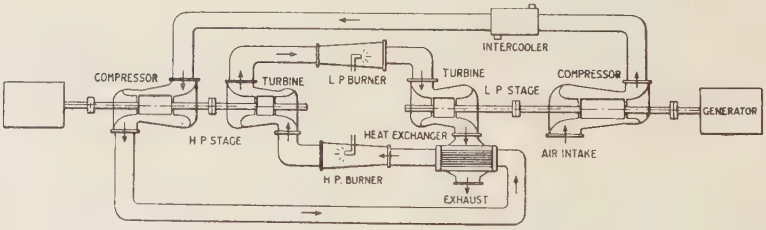


Fig. 1d. — Closed-circuit gas turbine.

thermal efficiency. A further development of the open-circuit arrangement is shown in Fig. 1c, where the compression and expansion are divided into two stages, an intercooler is provided between the compression stages, and a second burner between the two turbines. This more complex layout achieves a still greater thermal efficiency and clearly the multiplication of stages could be carried further.

Fig. 1d represents the closed circuit scheme. This can be regarded as a Robert Stirling in 1827 and later revived by Ericsson. The two great merits of the closed circuit are : (1) that the turbine operates with clean air; and (2) that the whole circuit can be put under pressure, *i.e.*, the lowest pressure in the cycle is kept at a level above atmospheric pressure, so that the rate of heat transfer is increased and the surface areas of the heat exchangers are correspondingly reduced.

As far as thermal efficiency is concerned, the two most attractive systems

are the closed circuit of Fig. 1d and the two-stage open circuit of Fig. 1c, with heat exchanger and intercooling between compression stages. However, both these systems have a grave disadvantage as regards application to locomotives. A supply of cooling water is required, and the gas turbine in either of these forms therefore presents the same problem as the condensing steam turbine when applied to locomotive practice.

Because of this cooling problem, the choice of a gas turbine system for a locomotive must be restricted to the open-circuit arrangement of Fig. 1a or 1b; or to a two-stage open-circuit system similar to Fig. 1c, but without any intercooler between the compression stages. These systems have the merit of extreme mechanical simplicity and relatively small weight and bulk.

Simple open-circuit turbine

In the simple open-circuit arrangement of Fig. 1a, air is taken in at atmospheric pressure and temperature, compressed in an axial flow compressor (1), and then passes to the combustion chamber (2) where liquid fuel is burnt continuously at constant pressure. The hot gases from the combustion chamber then pass to the turbine (3), in which energy is extracted during expansion, and the gases finally are exhausted at atmospheric pressure. A large proportion of the shaft power of the turbine is required for driving the compressor, but the balance of power output is available for useful work.

Idealised gas turbine cycle.

If the compression and expansion could be carried out in a strictly isentropic manner, the thermal efficiency of the cycle would be independent of the combustion temperature, and would depend only on the pressure ratio, in much the same way as in the Otto cycle for piston engines the « air standard efficiency » is a function of volume ratio of compression. Pressure-volume (p, v) and temperature-entropy (T, ϕ) diagrams * for this idealised gas turbine cycle are illustrated in Fig. 2. The line *ab* represents the process of compression; *bc* heating at constant pressure; *cd* expansion through the turbine; and *da* heat rejection in the exhaust at atmospheric pressure. Areas on the T, ϕ diagram represent heat quantities. The heat taken in per lb. of air is given by the area under the line *bc*, and the heat rejected in the exhaust is given by the area under the line *da*. The difference, *i.e.*, the enclosed area, represents the heat converted into useful work per lb. of air. It is assumed in the ideal cycle

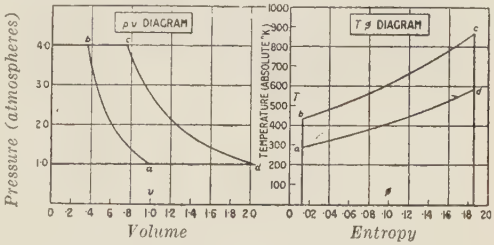


Fig. 2. — Pressure-volume and temperature-entropy diagrams for the idealised cycle.

* The entropy of a substance is defined as the quantity measured by the $\int \frac{dQ}{T}$ during a reversible process, where Q is the quantity of heat taken in by the substance and T is the absolute temperature. An arbitrary datum level has to be chosen, and this usually is taken so that the entropy is zero at 0° C. (273° K.), and standard atmospheric pressure (*i.e.*, 14.7 lb. per sq. in. approx.). In the diagrams accompanying this article the entropy is expressed relative to this zero level, and the values are per lb. of air or gas. It can be proved that entropy is a function of the state of a substance, *i.e.*, that at any particular pressure and temperature the entropy of the substance will have a fixed value.

that the working substance consists only of air.

In practice it is impossible to achieve strictly adiabatic compression and expansion. In any real air compressor, for instance, the temperature rise will be greater than the corresponding adiabatic temperature rise for the same ratio of compression. The adiabatic efficiency of a compressor is equal to the ratio of the ideal adiabatic temperature rise to the actual temperature rise in the compressor :—

$$i.e. \qquad \eta_c = \frac{T_b - T_a}{T_b' - T_a} = \frac{\left(\frac{p_b}{p_a}\right)^{\frac{\gamma-1}{\gamma}} - 1}{\frac{T_b'}{T_a} - 1}$$

where T_a = atmospheric temperature
T_b = temperature at end of ideal adiabatic compression
T_b' = actual temperature at outlet from compressor
p_a = atmospheric pressure
p_b = pressure at outlet from compressor

The result of this departure from the ideal cycle can be shown clearly on the T, ϕ diagram. In Fig. 3 the real compression line is represented by the curve ab' instead of the isentropic ab.

Similarly, the expansion in the turbine will not be strictly isentropic. Heat is generated in an irreversible manner by friction during the passage of the gas through the turbine, and there is a progressive increase of entropy as indicated by the line cd' in Fig. 3. The heat generated by friction during compression and expansion is at the expense of the total head of the gas stream, and consequently represents a loss of energy available for conversion into useful work. Since the compression and expansion processes are not reversible in the thermodynamic sense, the net enclosed area on the T, ϕ diagram no longer represents the heat converted into work.

The heat supplied from the combustion chamber is now represented by the area $fb'cg$ under the constant-pressure curve $b'c$, *i.e.*, C_p $(T_c - T_b')$ per lb. of air. C_p is the mean specific heat at constant pressure of the air or mixture of gases. C_p increases with temperature. For rough calculations it is possible to take a mean value appropriate to the relevant range of temperature and also to the particular gas mixture involved. For accurate calculations, however, it is better to use the T, ϕ diagram. The slope of a constant pressure line at

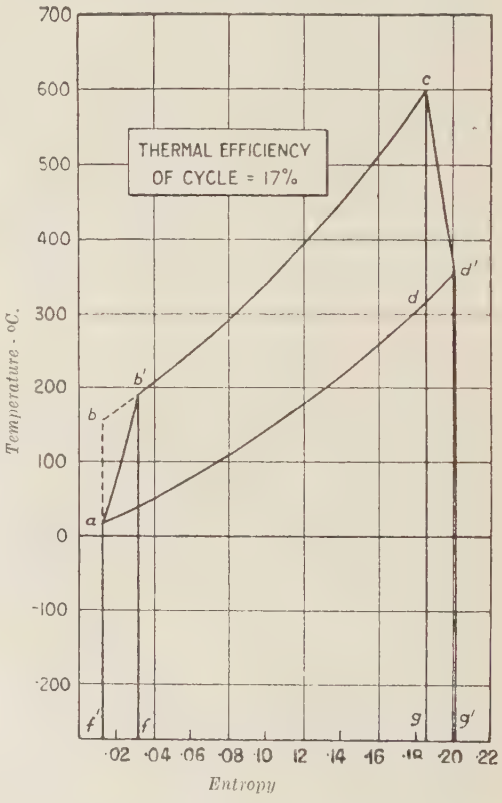


Fig. 3. — Variation in practice from the ideal entropy diagram of Fig. 2.

any point on the T,ϕ diagram is equal to $\frac{T}{C_p}$, and it is therefore possible to include the effect of variation of C_p with temperature when calculating the constant pressure lines.

Heat is supplied also to the air stream during compression and expansion, and the quantities are represented by the areas *f'ab'f* and *gcd'g'* under *ab'* and *cd'* respectively, but this heat is generated at the expense of the total head of the gas stream and is not supplied by the fuel. The heat rejected to the atmosphere is given by the area *g'd'af'* under *d'a, i.e.*, $C_p\,(T_d' - T_a)$.

The thermal efficiency is, therefore, given by :—

$$1 - \frac{\text{heat rejected}}{\text{heat received}} = 1 - \frac{(C_p\,(T_d' - T_a)}{C_p\,(T_c - T_b')}$$

A further small modification of this expression is necessary, however, to take account of the fact that the mass flow through the turbine is slightly greater than that through the compressor. The difference in mass flow represents the quantity of fuel burnt in the combustion chamber.

The heat converted into work per lb. of air is represented by the difference between the heat supplied and the heat rejected, that is, by the area *fb'cg* minus the area *f'ad'g'*. The principal effect of non-adiabatic compression and expansion is to cause the combustion temperature T_c to have a profound effect on the thermal efficiency. It is apparent from the *T*, ϕ diagram that the greater the temperature T_c, the larger will be the enclosed area, and hence the proportion of work wasted will be smaller.

Compressor and turbine efficiencies.

In order to see what thermal efficiencies are possible with the simple open-circuit turbine, it is necessary to make a few reasonable assumptions regarding the compressor and turbine efficiencies.

In Fig. 4a thermal efficiency is plotted against combustion temperature for pressure ratios of 4.0, 6.0, and 8.0 on the assumption that the adiabatic efficiency of the compressor is 80 per cent. for $\frac{p_b}{p_a} = 4.0$; 79 per cent. for $\frac{p_b}{p_a} = 6.0$;

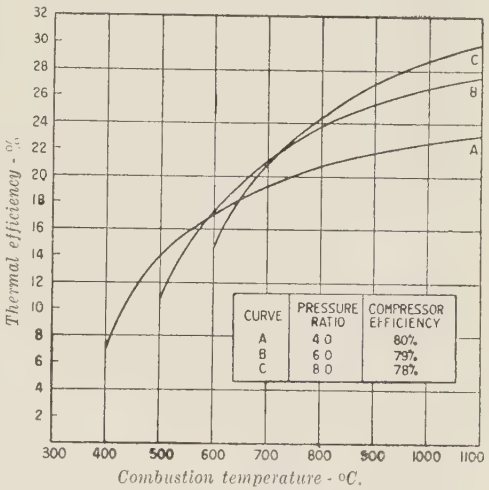


Fig. 4*a*. — Showing the effect of combustion temperature on thermal efficiency.

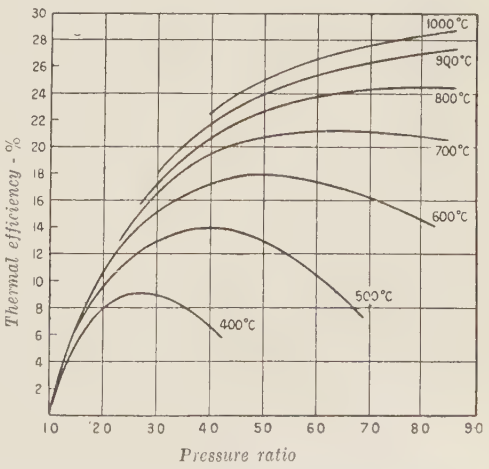


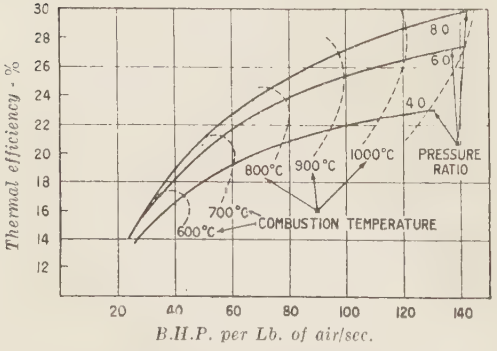
Fig. 4*b*. — Effect of pressure ratio on thermal efficiency, shown at various combustion temperatures.

and 78 per cent. for $\frac{p_b}{p_a} = 8.0$; these values corresponding to a constant polytropic or small-stage efficiency. For the turbine a small-stage efficiency of slightly over 83 per cent. has been assumed, which gives an efficiency ratio of 86 per cent. at pressure ratio 4.0. In Fig. 4b thermal efficiency is plotted against pressure ratio for various combustion temperatures.

In general, there will be an optimum pressure ratio for any fixed value of the combustion temperature T_c corresponding to maximum thermal efficiency. It is also evident from Fig. 4a that there is an envelope bounding the curves of thermal efficiency. This envelope represents the practical limit of thermal efficiency that can be attained with a simple open-circuit turbine. The exact position and shape of the envelope curve will depend on the compressor and turbine efficiencies, and their variation with pressure ratio. The overall thermal efficiency of a gas turbine is very sensitive indeed to compressor and turbine efficiency.

In Fig. 5a the curves of thermal efficiency, for pressure ratios of 4.0, 6.0, and 8.0, are plotted on a base of b.h.p. per lb. of air per sec. It must be stressed that these curves are of a general nature, based on the stated assumptions regarding compressor and turbine efficiencies. It is only when the exact characteristics of the compressor and turbine are known for a particular design that accurate performance curves can be computed. However, Fig. 5a gives a clear idea of the range of thermal efficiency available with the simple open-circuit turbine, and its dependence on pressure ratio and maximum permissible temperature at inlet to the turbine. In Fig. 5b curves similar to those of Fig. 5a are plotted with fuel consumption in place of thermal efficiency. A calorific value of 18 000 B.Th.U. per lb. of fuel oil (10 000 C.Th.U. per lb.) has been assumed.

For stationary turbines maximum temperatures are at present limited to about 600° to 650° C., depending on the material used for the turbine discs and blading. It is true that aircraft turbines are now operating with combustion temperatures of well over 800° C., but the working life of these machines is relatively short. With the application to stationary power or traction turbines of some of the special heat-resisting alloys developed for use in aircraft turbines, however, it should eventually be possi-



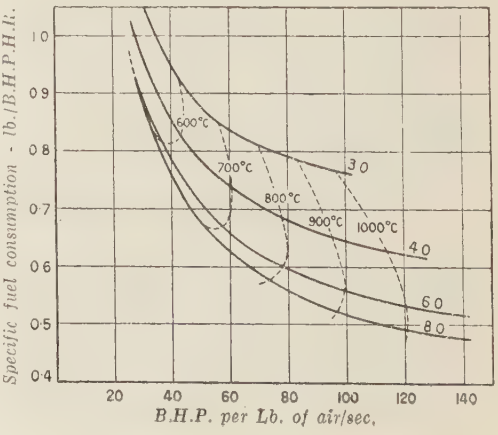


Fig 5*a* (above) and 5*b* (right). — Performance curves of open-circuit turbine.

ble to push up working temperatures to 700° C. or even 750° C. without sacrificing reliability. It will be observed from Fig. 4b or Fig. 5a that with a combustion temperature of 700° C. an overall thermal efficiency of slightly over 21 per cent. should be attained.

Open-circuit turbine with heat exchanger.

An obvious way of improving the thermal efficiency of the open-circuit turbine is to use some of the waste heat in the exhaust gases to pre-heat the air stream before entry to the combustion chamber. This is the arrangement illustrated in Fig. 1b. The temperature-entropy diagram for the cycle is shown in Fig. 6. From b' to h on the constant-pressure heating curve, heat is taken in by the air in passing through the heat exchanger. The remaining part of the curve, from h to c, represents the normal process of heating in the combustion chamber. From d' to k on the constant-pressure cooling curve, heat is given up by the exhaust gases in passing through the heat exchanger. The remainder of the curve from k to a represents the normal process of heat rejection to the atmosphere. The shaded area under $b'h$ is the quantity of heat per lb. of air transferred *to* the air in the heat exchanger, and is equal to the shaded area under $d'k$, which represents the quantity of heat transferred *from* the exhaust gases.

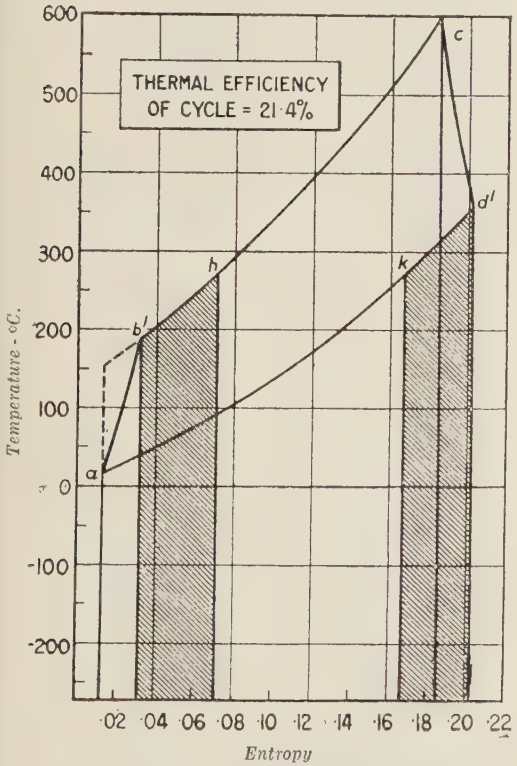


Fig. 6. — Temperature-entropy diagram for working cycle of open-circuit turbine with heat exchanger.

The greatest gain in thermal efficiency would be achieved if the air could be pre-heated to the temperature of the turbine exhaust, so that $T_h = T_{d'}$. This would make full use of the available heat represented by the temperature difference $T_{d'} - T_{b'}$. However, this obviously is not possible in practice, since there must be a temperature gradient across the heat exchanger at every point in order to maintain the flow of heat from the hot gases to the air. The greater the temperature gradient (or in other words, the greater the temperature difference $T_{d'} - T_h$) the smaller is the surface area of heat exchanger required for a given rate of heat transfer.

The heat available for transfer represented by the temperature difference $T_{d'} - T_{b'}$ between the turbine exhaust and the air at outlet from the compressor, increases with increase of combustion temperature, but decreases with increase of pressure ratio. The possible gain in thermal efficiency by using a heat exchanger is, therefore, greatest at the lower pressure ratios and high combustion temperatures. In fact, for a very high pressure ratio $T_{b'}$ may be greater

than T_d', in which case there is no application for a heat exchanger at all.

Fig. 6 is drawn to scale for the same conditions as Fig. 3, that is, for a pressure ratio of 4.0, combustion temperature 600° C., and the same compressor and turbine efficiencies as previously. The two $T\phi$ diagrams, therefore, provide a direct comparison of the open-circuit cycle with and without a heat exchanger. It is assumed that 50 per cent. of the heat theoretically available for transfer is actually exchanged, *i.e.*, T_h is taken as 273° C. This represents a rise of temperature of the air of 84° C. by pre-heating in the heat exchanger. The thermal efficiency of the cycle in this case should be 21.4 per cent. (compared with 17.0 per cent. without any heat exchange).

In Fig. 7 the thermal efficiency of an open-circuit turbine with heat exchanger is plotted, (*a*) against combustion

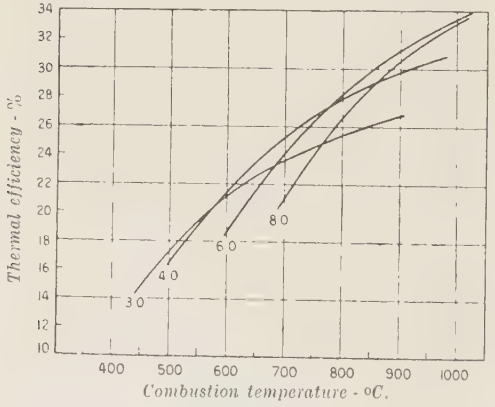


Fig. 7*a*. — Thermal efficiency curves of open-circuit turbine with heat exchanger, at various pressure ratios.

temperature for various pressure ratios, and (*b*) against pressure ratio for various combustion temperatures, on the assumption that 50 per cent. of the heat theoretically available for transfer actually is exchanged in each case. Figs. 7a and 7b may be compared with Figs. 4a and 4b. It will be observed that the optimum pressure ratio for any given combustion temperature is lower than in the case without heat exchange. With a maximum permissible combustion

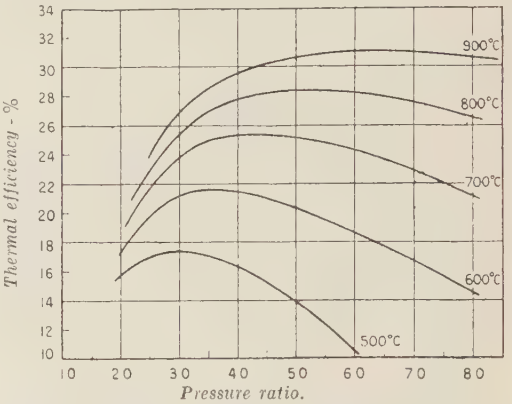


Fig. 7*b*. — Thermal efficiency curves of open-circuit turbine with heat exchanger, at various combustion temperatures.

temperature of 700° C., a thermal efficiency of about 25 per cent. should be possible.

Further developments with combustion turbines.

If a high pressure ratio is required, it is convenient to have two separate compression stages arranged in series (*i.e.*, two mechanically independent stages; each compressor will have several rows of blades or « small stages »). In this way the problem of starting is eased considerably. With a stationary turbine plant it would be natural to arrange an intercooler between the two compression stages, but this is not possible with a locomotive turbine. However, if the expansion is divided between two separate turbines, a second combustion chamber can be incorporated between the two turbine stages. A T, ϕ diagram for this arrangement is shown in Fig. 8.

If there is no heat exchanger, nothing will be gained in thermal efficiency by

employing two separate combustion chambers and turbines. The work area of the diagram will, however, be slightly larger, and so there will be a small increase in the b.h.p. per lb. of air per sec. However, with a heat exchanger in the circuit the thermal efficiency will be higher for the two-stage arrangement,

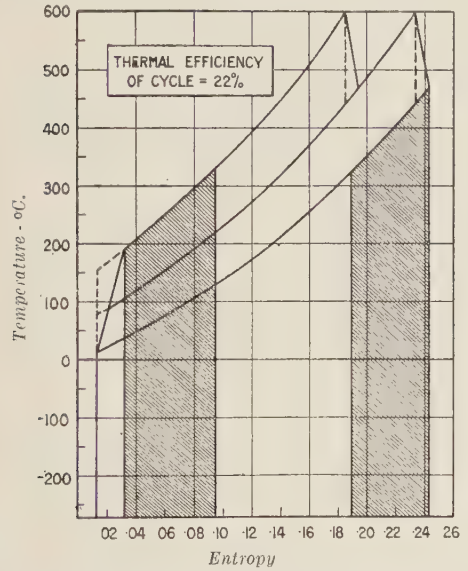


Fig. 8. — Temperature-entropy diagram of two-stage turbine with separate combustion chambers and heat exchanger.

because the exhaust temperature is higher, and, therefore, the quantity of heat available for transfer is greater. The extent of the gain will depend on the size of the heat exchanger. In Fig. 8 the overall pressure ratio is 4.0, and with a maximum combustion temperature of 600° C., the thermal efficiency with 50 per cent. heat exchange is 22.0 per cent. With maximum combustion temperature 700° C., the thermal efficiency should be over 25 per cent. provided the same proportion of heat exchange is maintained. With higher proportions of heat exchange, correspondingly higher thermal efficiencies would be attained.

With the two-stage circuit it may be convenient to divide the expansion unequally between the turbines and take all the useful power from one machine. For instance, the h.p. turbine could be designed to operate through a smaller pressure ratio than the h.p. compressor, in such a manner that it would provide just enough power to drive the compressor, but without any surplus shaft power. The l.p. turbine would then operate through a greater pressure range and would develop all the useful power of the circuit. An alternative arrangement is to divide the expansion into three stages and have an entirely separate « power « turbine.

Effect of atmospheric temperature.

All calculations so far have been based on an atmospheric temperature of 15° C. (59° F.). The power output and efficiency of a gas turbine increase with fall of temperature and decrease with rise of temperature. For this reason gas turbine locomotives will be better suited for operation in countries having a cold climate than in tropical regions.

In conclusion, it may be said that a thermal efficiency of about 24-25 per cent. is an immediate practical possibility for a gas turbine plant suitable for installation in a locomotive. The overall efficiency at the drawbar should, therefore, be about 20 per cent. This falls short of the 28-30 per cent. efficiency of the modern diesel-electric locomotive, but when account is taken of the fact that the fuel oil required for gas turbines is much cheaper than diesel fuel, and also that lubrication costs are less with the turbine, running costs actually should be lower for the gas turbine-electric locomotive. Everything will depend, however, on reaching a high degree of reliability without excessive maintenance. Availability in railway service is the vital matter if gas turbine traction is to become a serious rival to diesel traction.

MONTHLY BIBLIOGRAPHY OF RAILWAYS[1]

PUBLISHED UNDER THE SUPERVISION OF

P. GHILAIN,

General Secretary of the Permanent Commission of the International Railway Congress Association.

(JANUARY 1947)

[016. 385. (02]

I. — BOOKS.

In French.

1946 **69 (02**

ARBIER (M.).

Les procédés modernes de construction.

Paris, Presses Universitaires de France. 1 volume in-8° .75×115) de 128 pages, avec 68 figures.

1946 **625 .14**

AMPUS (R.).

La réalisation d'une voie ferrée de qualité. Les résul-ts techniques, économiques et sociaux de quinze années organisation. Prix Charles Lemaire 1946 de la Classe s Sciences de l'Académie Royale de Belgique.

Un volume (21×30) de 251 pages, 87 figures et 41 plan-es. En vente chez l'auteur, 131, avenue de Broqueville, Bruxelles.

1946 **385. (09 .1 (.4)**

rte ferroviaire d'Europe.

Bâle, Editions « Transport », Rittmann et Bauer, S. A. ormat 90×128 cm. (d'après les frontières de 1946).

1946 **0**

EISZLER (S.), VAN DEN BERG (R.), ARIES (P.) & LE MINOR (M.).

Fonctionnement d'un centre de documentation.

Paris, Société d'Editions techniques coloniales, 1 vo-me (16×23 cm.) de 370 pages, avec figures et tableaux. Prix : 300 fr. français.)

1946 **621 .133 .3**

ERON (M.).

Conception actuelle des surchauffeurs. Tome II.

Paris, éditeur : Hermann et Cie, 6, rue de la Sor-onne. 1 brochure (21×27 cm.) de 96 pages, 20 figures 1 graphique hors-texte. (Prix : 140 fr. français.)

In English.

1946 **621 .132 .3 (.68)**

8-2 Class « F » locomotives for the South African Railways.

London : The Railway Gazette, 33 Tothill Street, Westminster, S. W. 1. (Price : 2 sh.)

1946 **656. (06 (.4)**

EUROPEAN CENTRAL INLAND TRANSPORT ORGANISATION.

The transport situation in Europe.

No. 10, July, 1946. A publication of 62 pages published by E. C. I. T. O., 79, avenue des Champs Elysées, Paris VIII[e]. (Price : 5 sh. net.)

1946 **656. (06 (.4)**

EUROPEAN CENTRAL INLAND TRANSPORT ORGANISATION.

The transport situation in Europe.

No. 11, August, 1946. A publication of 64 pages published by E. C. I. T. O., 79, Avenue des Champs Elysées, Paris VIII[e]. (Price : 5 sh. net.)

1946 **621 .431 .72**

FOELL (C. F.) and THOMPSON (M. E.).

Diesel-electric locomotive.

New-York : published by Diesel Publications, Cloth (6×9 1/2 in.), 688 pp., illus., diagrams, charts, tables. (Price : 7 $.)

1946 **385**

HUNGERFORD (E.).

Railroad for tomorrow, 1960.

Milwaukee (Wis.) : Published by Kalmbach Publishing Co., November 1945. Limited first edition. Cloth (6 ×9 1/4 in.), 323 pp., illus., tables. (Price : 5 $.)

1946 **621 .392 (.73)**

Manual of design for arc-welded steel structures.

New York : Published by The Air Reduction Sales Company, 60 E 42nd-Street, New York 17, 281 pages (6 in. by 9 in.). Bound in fabrikoid. (Price : 2 $.)

1946 **313 .385 (.42)**

MINISTRY OF WAR TRANSPORT.

Summary table of statistical returns of railways of Great Britain. 1938 to 1944.

London : His Majesty's Stationery Office. (Price : 4 d. net.)

---

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress con-intly with the Office Bibliographique International, of Brussels. (See « Bibliographical Decimal Classification as applied to Railway ience », by L. WEISSENBRUCH, in the number for November 1897, of the *Bulletin of the International Railway Congress*, p. 1509).

1946 **313 .385 (.42)**

MINISTRY OF TRANSPORT.

Summary table of statistical returns of railways of Great Britain. 1945.

London: His Majesty's Stationery Office. (Price: 4 d. net.)

1946 **385. (06 (.73)**

Proceedings of the American Railway Engineering Association for 1946.

Chicago : Published by the Association, 59 East Van Buren Street. 786 pages, illustrated. Bound in cloth, $ 8.00; in half morocco, $ 9.00.

1946 **621 .438**

SAWYER (T.).

The modern gas-turbine.

London: Publishers: Sir Isaac Pitman and Sons, Ltd. (Price : £ 1.1.0 d. net.)

1946 **62 (01**

SOKOLNIKOFF (I. S.) and SPECHT (R. D.).

Mathematical Theory of Elasticity.

New York : McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York, U. S. A. (Price: 4,50 $.)

London : McGraw-Hill Publishing Company, Limited, Aldwyck House, Aldwyck, W.C. 2. (Price : 22 sh., 6 d.)

1946 **621**

TREWMAN (H. F.).

Mechanical inspection. A survey of the underlying principles and practical aspects of mechanical inspection, with special reference to precision engineering.

London: Sir Isaac Pitman and Sons, Limited, Parker Street, Kingsway, W. C. 2. (Price: 15 sh. net.)

In Spanish.

1946

LOPEZ JAMAR (J. A.).

Nomogramas para el calculo directo de las seccione hormigón armado.

La Coruña, Editorial « Roel ». Un tomo apaisa encuadernado en cartoné, con texto justificativo y e cativo y 115 nomogramas, tamaño 22×32 cm. (Pr 110 pesetas.)

1946 **624 (**

MINISTERIO DE OBRAS PUBLICAS (Ecuador).

El progreso del plan de obras publicas nacionale cifras. (Mayo de 1944 a Julio de 1946.)

Quito, Talleres Graficos Nacionales. 1 volume 10 paginas (cuadros).

In Italian.

1946

SANTARELLA (L.).

Il cemento armato. Volume II: **La Tecnica e la Sta** 11ª edizione rifatta.

Milano, editore Hoepli, 1 volume in-8° di pagine 444, con 270 figure nel testo. (Prezzo: 500 lire.)

In Dutch.

1946 **625**

CAMPUS (R.).

Het tot stand komen van een voortreffelijk s Resultaten, op technisch, economisch en sociaal ge van vijftien jaar organisatie. Prijs Charles Lemaire van de Klas der Wetenschappen der Koninklijke demie van België.

Een boek (21×30), 260 bladzijden, 87 teekeninge 41 platen. Te koop bij den schrijver, de Broqueville 131, Brussel.

[016. 385. (05]

II. — PERIODICALS.

In French.

Annales des Mines et des Carburants. (Paris.)

1946 **669**

Annales des Mines et des Carburants, n° 12, 30 juin, p. 959.

L'avenir des **métaux légers.** (Note de la mission du Ministère de la Production industrielle à Londres.) (3.000 mots.)

Annales des Ponts et Chaussées. (Paris.)

1946 **624.2**

Annales des Ponts et Chaussées, mai-juin, p. 289.

LAZARD (A.). — **Flambement en milieu élastique discontinu.** Efficacité d'un dispositif de contre-flambage. (7 500 mots, tableaux & fig.)

Bulletin de l'Union Internationale des Chemins de fer. (Paris.)

1946 **656**

Bull. de l'Union intern. des Chemins de fer, octo p. 152.

Concurrence et coopération en trafics voyageurs et chandises entre chemin de fer et automobile (ju août 1946). Rapport des Chemins de fer fédéraux sui (10 000 mots.)

Bulletin des C. F. F. (Berne.)

1946 **625 .1 (.**

Bulletin des C. F. F., n° 12, décembre, p. 188.

NABHOLZ (P.). — **Double voie** Rivera/Bironic Taverne/Torricella. (1 500 mots & fig.)

1946 **625 .1 (.494) & 625 .174 (.494)**

Bulletin des C. F. F., nº 12, décembre, p. 190.

ZANOLARI (B.). — La **galerie de protection contre les avalanches** de l'Aecheribach entre Amsteg et Gurtnellen. (600 mots & fig.)

Bulletin des Transports internationaux par chemins de fer. (Berne.)

1946 **347 .762 (.493)**

Bull. des transp. intern. par ch. de fer, avril, p. 133.

CLERENS-STAS (A.). — Le **contrat de transport** et la force majeure en droit belge. (6 000 mots.)

1946 **385 .113 (.485)**

Bull. des transp. intern. par ch. de fer, avril, p. 169.

Les prestations des **Chemins de fer de l'Etat suédois** durant la guerre et les projets d'après-guerre. (600 mots.)

1946 **385 .4 (.494)**

Bull. des transp. intern. par ch. de fer, avril (annexe), p. 31; mai (annexe), p. 37.

Règlement d'exécution du 15 février 1946 de la **loi du 23 juin 1944 sur les Chemins de fer fédéraux.** (4 000 mots.)

1946 **385 .62 & 385 .63**

Bull. des transp. intern. par ch. de fer, mai, p. 179.

L'influence de la guerre sur les Conventions internationales concernant le transport par chemins de fer des voyageurs et des bagages (C I V) et des marchandises (C I M). (6 000 mots.)

1946 **656 .213 (.44)**

Bull. des transp. intern. par ch. de fer, mai, p. 196.

DURAND (P.). — Le **régime juridique des voies de quai** en France. (2 800 mots.)

1946 **621 .33**

Bull. des transp. intern. par ch. de fer, mai, p. 211.

Les **chemins de fer électriques** et la dernière Conférence mondiale de l'énergie. (600 mots.)

1946 **385 .63**

Bull. des transp. intern. par ch. de fer, juin, p. 238.

DE LA MASSUË (H.). — **Livraison tardive et dommages-intérêts.** (4 500 mots.)

1946 **385. (09 (.497 .1)**

Bull. des transp. intern. par ch. de fer, juillet, p. 291.

VELIMIROVITCH (St.). — Les **Chemins de fer de l'Etat yougoslave** après la guerre. (2 500 mots.)

1946 **621 .33 (.436)**

Bull. des transp. intern. par ch. de fer, juillet, p. 307.

L'**électrification** des Chemins de fer de l'Etat autrichien. (700 mots.)

1946 **625 .162 (.44) & 656 .254 (.44)**

Bull. des transp. intern. par ch. de fer, juillet, p. 309.

Réglementation des passages à niveau établis pour la traversée des lignes et embranchements composant le réseau de la Société nationale des Chemins de fer français. (900 mots.)

1946 **385. (09 (.45)**

Bull. des transp. intern. par ch. de fer, juillet, p. 311.

La **situation des transports** en Italie. (1 500 mots.)

1946 **385 .113 (.494)**

Bull. des transp. intern. par ch. de fer, juillet, p. 314.

Rapport sur la gestion et les comptes des Chemins de fer fédéraux suisses pour 1945. (2 000 mots.)

1946 **313 : 385 (.489)**

Bull. des transp. intern. par ch. de fer, juillet, p. 327.

Les **Chemins de fer de l'Etat danois** pendant l'exercice 1944/1945. (Tableaux.)

1946 **347 .763 .4 (.45)**

Bull. des transp. intern. par ch. de fer, août, p. 343.

CHIMENTI (E.). — La **législation italienne des transports par fer** pendant la guerre. (4 000 mots.)

1946 **385 .62 & 385 .63**

Bull. des transp. intern. par ch. de fer, septembre, p. 387.

Etat, en date du 1er juillet 1946, des **trafics directs internationaux et des tarifs internationaux** se fondant sur la C I V et la C I M. (5 600 mots.)

Bulletin Sécheron. (Genève.)

1942 **621 .335 (.494) & 625 .3 (.494)**

Bulletin Sécheron, nº 14, p. 1.

Les 50 ans de **chemins de fer électriques à crémaillère** (1892-1942). Fourgons automoteurs du Brünig. Motrices du Furka-Oberalp et des Schoellenen, pour **service combiné adhérence-crémaillère.** (1 500 mots & fig.)

Economie et Technique des Transports. (Lucerne.)

1946 **621 .336**

Economie et technique des transports, octobre, p. 80.

LEYVRAZ (L. H.). — Le récent développement des **compresseurs et pompes à vide pour la traction.** (1 800 mots & fig.)

Electricité. (Paris.)

1946 **537 .7**

Electricité, nº 121, novembre, p. 227.

Instruments de **mesures électriques.** (5 000 mots & fig.)

1946 **621 .392**

Electricité, nº 121, novembre, p. 240.

Facteurs principaux intervenant dans le **soudage par points des métaux légers.** (2 000 mots & fig.)

Génie Civil. (Paris.)

1946 **621 .132 .8 (.73)**

Génie Civil, n° 3186, 1er août, p. 209.

La **locomotive 343 à turbines à vapeur** du Pennsylvania Railroad. (1 000 mots & fig.)

1946 **62. (01**

Génie Civil, n° 3187, 15 août, p. 219.

PROT (M.). — Résistance des matériaux. Vues actuelles sur la notion de **coefficient de sécurité.** (2 200 mots & fig.)

1946 **621 .132 .3 (.44) & 621 .132 .5 (.44)**

Génie Civil, n° 3188, 1er septembre, p. 225.

MACHEFERT-TASSIN (Y.). — Les nouvelles **locomotives franco-américaines 141-R.** (3 000 mots, 1 tableau & fig.)

1946 **385. (09 (.492) & 623 (.492)**

Génie Civil, n° 3189, 15 septembre, p. 245.

Les **destructions** causées par la guerre aux Chemins de fer néerlandais. (1 200 mots & fig.)

1946 **691**

Génie Civil, n° 3190, 1er octobre, p. 259.

VILLEY (J.). — Recherches expérimentales relatives au **néobéton.** (3 500 mots.)

1946 **62. (01 & 621 .392**

Génie Civil, n° 3190, 1er octobre, p. 266.

PORTEVIN (A.), LEROY (A.) & GRANJON (H.). — Phénomènes d'**auto-trempe en soudure.** (1 200 mots.)

1946 **691**

Génie Civil, n° 3190, 1er octobre, p. 267.

La **conservation des bois** par imprégnation de composés arsénifères ; le procédé suédois Boliden. (1 200 mots.)

1946 **621 .132 .8 (.73)**

Génie Civil, n° 3192, 1er novembre, p. 294.

Les **locomotives américaines récentes.** (3 500 mots & fig.)

1946 **624 .63 (.494)**

Génie Civil, n° 3193, 15 novembre, p. 312.

Le **pont-rail en béton** de la Jonction, à Genève. (2 500 mots & fig.)

Mécanique (Bulletin de la Société française des Mécaniciens) (Paris).

1946 **621 .95**

Mécanique, novembre, p. 261.

FARRENQ (R.) & SCHWEYCKART (R.). — Le **fraisage** des alliages légers. (2 000 mots, tableaux & fig.)

Revue de l'Association française des Amis des Chemins de fer. (Paris.)

1946 **621 .33 (.4**

Revue de l'Ass. fr. des amis des Ch. de fer, n° 1 mai-août, p. 49.

GACHE (A.). — Le **développement de l'électrificati** des Chemins de fer français. Continu 3 000 volts, mo phasé 15 000 volts ou continu 1 500 volts? (6 000 mots fig.)

1946 **625 .232 (.4**

Revue de l'Ass. fr. des amis des Ch. de fer, n° 1 mai-août, p. 58.

LEJEUNE. — Perfectionnements en voie d'applicati dans la **construction des voitures** et de leurs organes roulement. (2 500 mots.)

Revue générale des chemins de fer. (Paris.)

1945 **623 (.44) & 624 (.4**

Revue générale des Chemins de fer, novembre-décemb p. 121.

Destructions et reconstructions sur les Chemins de f français. Les ouvrages d'art de la Grande-Ceinture, p M. LEDUC. — Le viaduc de Chaumont (P. K. 260.7 de la ligne Paris-Bâle), par M. OUDOTTE. — Le po de Beillant sur la Charente, par MM. MARCHAIS CAUVY. — Le pont Résal sur la Loire à Nantes, p M. ROBERT. — Le viaduc de Maintenon (ligne Par Chartres). — Le viaduc de la Vezeronce (ligne Lyo Genève). — Le pont d'Orléans (ligne des Aubrais Montauban). — Le pont de Montlouis sur la Loi (ligne Paris-Bordeaux). — Le pont de Saint-Clair Lyon sur le Rhône (ligne de Lyon à Ambérieu). — L viaducs entre Blaisy-Bas et Dijon. (7 000 mots, tablea & fig.)

1946 **656 .225 (.44) & 656 .235 (.4**

Revue générale des Chemins de fer, janvier-février, p.

BOYAUX & DARGEOU. — Modification du régi d'acheminement et de tarification des **transports de ma chandises** sur la S. N. C. F. (3 000 mots, tableaux carte.)

1946 **621 .133 .3 & 6**

Revue générale des Chemins de fer, janvier-février, p.

ARMAND (L.) & PETIT (R.). — La **corrosion d chaudières** de locomotives à vapeur. (5 000 mots, t bleaux & fig.)

1946 **656 .222 .5 (.4**

Revue générale des Chemins de fer, janvier-février, p. 1

GOUDARD (J.). — La reprise du **trafic voyageurs** s la S. N. C. F. depuis la libération. (3 000 mots.)

1946 **625 .18 (.4**

Revue générale des Chemins de fer, janvier-février, p. 2

La récupération du **matériel de voie courante** à S. N. C. F. (800 mots & fig.)

1946 **656 .235 .7 (.44)**
Revue générale des Chemins de fer, nº 2, mars-avril, p. 25.
BOURGEOIS. — La nouvelle **tarification des colis de faible poids.** (5 500 mots, tableaux & fig.)

1946 **625 .231 (.44) & 625 .232 (.44)**
Revue générale des Chemins de fer, nº 2, mars-avril, p. 34.
FORESTIER. — Les **nouveaux véhicules métalliques à grande vitesse** de la S. N. C. F. (4 200 mots & fig.)

1946 **656 .255 (.44)**
Revue générale des Chemins de fer, nº 2, mars-avril, p. 44.
MARCHAND. — Le **règlement S. N. C. F. de voie unique.** (2 200 mots.)

1946 **656 .213 (.44)**
Revue générale des Chemins de fer, nº 3, mai-juin, p. 57.
LARIDAN (J.). — La **gare frigorifique** de Perpignan (6 000 mots & fig.)

1946 **621 .431 .72 (.44)**
Revue générale des Chemins de fer, nº 3, mai-juin, p. 64.
TOURNEUR. — **Nouveaux autorails diesel-électriques de 600 ch.** de la S. N. C. F. (1 000 mots, 1 tableau & fig.)

1946 **621 .133 .1 (.44)**
Revue générale des Chemins de fer, nº 3, mai-juin, p. 72.
CASTAN. — Le service de **machines américaines chauffées au mazout,** pour la traction en banalité complète des trains dans la vallée du Rhône. (1 700 mots & fig.)

1946 **625 .113**
Revue générale des Chemins de fer, nº 3, mai-juin, p. 75.
BIENFAIT (L.). — Le **mécano diagramme correcteur.** (2 500 mots & fig.)

In German.

Der Bahn-Ingenieur. (Berlin.)

1942 **621 .392 & 625 .212**
Der Bahn-Ingenieur, Nr. 27/28, 5./12. Juli. S. 245.
Eine neue selbsttätige **Spurkranz - Schweissanlage.** (1 600 Wörter & Abb.)

1942 **385 .524**
Der Bahn-Ingenieur, Nr. 27/28, 5./12. Juli, S. 250.
KÖNIG (H.). — Das **Prämienverfahren,** eine vereinfachte Form der Leistungslohnermittlung während des Krieges. (2 800 Wörter.)

1942 **621 .138 .5 (.43) & 625 .26 (.43)**
Der Bahn-Ingenieur, Nr. 29/30, 19./26. Juli, S. 263.
BÖLLING. — Die Einheitsbauarten der **Fahrzeughebeböcke** bei der Deutschen Reichsbahn. (1 200 Wörter & Abb.)

1942 **624**
Der Bahn-Ingenieur, Nr. 31/32, 2./9. August, S. 281.
MORGENROTH (F.). — **Brückenmesstechnik.** IV : Hilfsgeräte und Hilfsmittel. (3 000 Wörter & Abb.)

1942 **621 .33**
Der Bahn-Ingenieur, Nr. 31/32, 2./9. August, S. 292.
OTTO (G.). — Überblick über den **elektrischen Zugbetrieb.** (2 000 Wörter & Abb.)

1942 **621 .134 .1, 621 337 & 621 .431 .72**
Der Bahn-Ingenieur, Nr. 33/34, 16./23. August, S. 301.
SCHMIDT (W.). — Schnellansprechendes **Schleuderrelais für Triebfahrzeuge.** (3 500 Wörter & Abb.)

1942 **625 .112 & 656 .25**
Der Bahn-Ingenieur, Nr. 33/34, 16./23. August, S. 307.
CAMRATH (W.). — Einige Vorschläge zur **Sicherung von Zugfahrten auf gemischtspurigen Gleisen.** (6 000 Wörter & Abb.)

1942 **624 & 625 .142**
Der Bahn-Ingenieur, Nr. 35/36, 30. August/6. September, S. 321.
HAILER (J.). — Berechnung der **Einkämmung von Brückenschwellen in Gleiskrümmungen auf stählernen Eisenbahnbrücken.** (1 600 Wörter & Abb.)

1942 **621 .9**
Der Bahn-Ingenieur, Nr. 35/36, 30. August/6. September, S. 329.
OTTO (G.). — Pflege, Instandhaltung und Beschaffung von **Werkzeugmaschinen.** (5 000 Wörter.)

1942 **313 : 625**
Der Bahn-Ingenieur, Nr. 37/39, 13./27. September, S. 356.
OTTO (A.). — Auswertung der **Werkstatistik.** (1 600 Wörter.)

1942 **625 .26 (.43)**
Der Bahn-Ingenieur, Nr. 40/41, 4./11. Oktober, S. 362.
KAYSER & GRÜTER. — Wirtschaftliche Arbeitsverfahren und Vorrichtungen im **technischen Betriebswagendienst.** (3 500 Wörter & Abb.)

1942 **625 .144 .2**
Der Bahn-Ingenieur, Nr. 40/41, 4./11. Oktober, S. 368.
JIRA (F.). — Das **Krümmungsbild** als Grundlage der Linienverbesserung (Umgestaltung des Biegeverfahrens). (3 000 Wörter, 1 Tafel & Abb.)

1942 **625 .144 .2**
Der Bahn-Ingenieur, Nr. 44/45, 1./8. November, S. 412.
TUSCHE. — Entwurf einer **Verbindungskurve** nach dem Winkelbildverfahren von einem Vieleckzuge aus. (1 000 Wörter & Abb.)

1942 **656 .254**
Der Bahn-Ingenieur, Nr. 48/49, 29. November/6. Dezember, S. 452.
KÖNIG (R.). — Die physikalischen Grundlagen der **induktiven Zugbeeinflussung.** (800 Wörter & Abb.)

1943 **625 .251**
Der Bahn-Ingenieur, Nr. 1/2, 3./10. Januar, S. 3.
SCHRAGE (C.). — Hohlgegossene Futterstücke für **Weichen.** (500 Wörter & Abb.)

1943 **621 .33**
Der Bahn-Ingenieur, Nr. 1/2, 3./10. Januar, S. 11.
WILD (W.) & OCHEM (H.). — Die Beeinflussung von Fernkabeln durch **Wechselstrom-Bahnanlagen.** (4 000 Wörter & Abb.)

1943 **621 .19 (.43) & 662 (.43)**
Der Bahn-Ingenieur, Nr. 3/4, 17./24. Januar, S. 22.
PEHMÖLLER (W.). — Heize richtig, heize sparsam! (Hochstwertgebrauchsätze der Brennstoffe; Bedienung und Überwachung der **Heizungsanlage** im Dienstgebaüde der Reichsbahndirektion Hamburg). (2 700 Wörter.)

Die Lokomotive. (Bielefeld-Berlin.)

1943 **625 .254**
Die Lokomotive, Nr. 11, November, S. 203.
METZELTIN. — Die Geschichte der **Saugluftbremse.** (1 200 Wörter & Abb.)

1943 **621 .134 .2**
Die Lokomotive, Nr. 11, November, S. 205.
RIHOSEK (J.). — **Steuerungen** ohne Geradführung der Schieberstange. (500 Wörter & Abb.)

1943 **621 .132 .8**
Die Lokomotive, Nr. 12, Dezember, S. 219.
SCHNEIDER (L.). — **Turbinenlokomotiven** mit Auspuffbetrieb. (1 100 Wörter & Abb.)

1943 **621 .132 .7 (.43)**
Die Lokomotive, Nr. 12, Dezember, S. 221.
METZELTIN. — Vorschlag für eine neue **Verschiebe-Lokomotive.** Sind unsere Verschiebe-Lokomotiven zeitgemäss? (2 500 Wörter, Tafeln & Abb.)

1943 **621 .132 .8**
Die Lokomotive, Nr. 12, Dezember, S. 225.
METZELTIN. — Die Entwicklung der **Franco-Lokomotive.** (1 200 Wörter & Abb.)

1944 **621 .132 .8**
Die Lokomotive, Nr. 1, Januar, S. 1.
FARMAKOWSKY (W.). — Das Verdampfungsvermögen der **Hochdruck-Wärmespeicher feuerloser Lokomotiven** (Gilli-Lokomotiven). (1 600 Wörter & Abb.)

1944 **621 .392 & 625 .212**
Die Lokomotive, Nr. 1, Januar, S. 5.
THIEMER (E.). — Fortschritt und Leistungssteigerung durch Einsatz einer **Radsatz-Spurkranz-Schweissanlage** neuer Bauart. (2 400 Wörter & Abb.)

1944 **625 .25**
Die Lokomotive, Nr. 1, Januar, S. 9.
METZELTIN. — Die Entwicklung der **Gegendruckbremse.** (2 400 Wörter & Abb.)

1944 **621 .133 .**
Die Lokomotive, Nr. 2, Februar, S. 21.
Kesselsteinbildung bei Lokomotiven, ihre Ursache und Wirkungen. (7 000 Wörter & Abb.)

1944 **621 .133 .**
Die Lokomotive, Nr. 3, März, S. 37.
STEJSKAL (J.). — Erhöhung der **Dampfüberhitzung** durch Verkleinerung der Überhitzerheizfläche. (2 50 Wörter & Abb.)

1944 **621 .431 .7**
Die Lokomotive, Nr. 3, März, S. 41.
MAYER (M.). — Untersuchungen über den unmittelbaren **Antrieb von Diesellokomotiven,** I. (4 500 Wörter Zahlentafeln & Abb.)

1944 **621 .132 .7 (.43**
Die Lokomotive, Nr. 4, April, S. 57.
SEIDL (O.). — Eine neuzeitliche **Werkslokomotive** – der Kriegsausweichtyp K D L 8. (3 000 Wörter, 2 Zusammenstellungen & Abb.)

1944 **621 .132 .8 (.86**
Die Lokomotive, Nr. 4, April, S. 65.
KEMPER (F.). — Das Verkehrsproblem von Bogotá und seine Lösung durch die **Dampflokomotive.** (2 30 Wörter, 1 Tafel & Abb.)

1944 **621 .133 .6**
Die Lokomotive, Nr. 4, April, S. 69.
METZELTIN. — **Lamellen-Wasserabscheider.** (1 500 Wörter & Abb.)

Organ für die Fortschritte des Eisenbahnwesens (Berlin.)

1942 **656 .211 .5**
Organ für die Fortschritte des Eisenbahnwesens, Heft 22, 15. November, S. 343.
PIRATH (C.). — **Ablaufanlagen auf Abstellbahnhöfen für Reisezüge** im Fernverkehr. (3 700 Wörter, 1 Tabelle & Abb.)

1942 **621 .431 .72 (.61)**
Organ für die Fortschritte des Eisenbahnwesens, Heft 22, 15. November, S. 348.
SCHROETER (H.). — **Triebwagenbetrieb** der tunesischen Bahnen. (1 500 Wörter & Abb.)

1942 **625 .14 (.57)**
Organ für die Fortschritte des Eisenbahnwesens, Heft 22, 15. November, S. 350.
SALLER (H.). — **Eisenbahnbau** auf Boden ewiger Gefrörnis. (3 500 Wörter & Abb.)

1942 **625 .144 .**
Organ für die Fortschritte des Eisenbahnwesens, Heft 22, 15. November, S. 355.
SCHWANTER. — Die Länge des Übergangsbogens (500 Wörter & Abb.)

1942 **621 .431 .72 (.43)**
rgan für die Fortschritte des Eisenbahnwesens, Heft 23, 1. Dezember, S. 363.
TASCHINGER (O.). — Die neuere Entwicklung der **eseltrieb-, Steuer- und Beiwagen** der Deutschen Reichsahn. (Wagenbaulicher Teil.) (13 000 Wörter, 2 Tabeln & Abb.)

1942 **621 .431 .72**
rgan für die Fortschritte des Eisenbahnwesens, Heft 23, 1. Dezember, S. 380.
HEGENBARTH (F.). — Die **Anordnung der Kühler** n Verbrennungstriebwagen. (5 000 Wörter & Abb.)

1942 **621 .131 .1, 621 .335 & 621 .431 .72**
rgan für die Fortschritte des Eisenbahnwesens, Heft 24, 15. Dezember, S. 387.
LUBIMOFF (W.). — Über leistungsfähige **Lokomotiven und ihre Wirkungsgrade** (5 500 Wörter & Abb.)

1942 **625 .251 (.43) & 625 .253 (.43)**
rgan für die Fortschritte des Eisenbahnwesens, Heft 24, 15. Dezember, S. 394.
SCHRÖDER. — Der **Gleichschützregler,** eine Voraussetzung für Hochleistungsbremsen (3 000 Wörter & Abb.)

1943 **621 .332**
Organ für die Fortschritte des Eisenbahnwesens, Heft 1, 1. Januar, S. 1.
WILKE (G.). — Die **Stromfortleitung über die Fahrleitung elektrischer Bahnen.** (4 500 Wörter & Abb.)

1943 **385 .1 (.43)**
Organ für die Fortschritte des Eisenbahnwesens, Heft 1, 1. Januar, S. 8.
SCHULZE-MANITIUS (H.). — Die **finanzielle Entwicklung der deutschen Eisenbahnen.** (5 500 Wörter & Abb.)

1943 **624 (0**
Organ für die Fortschritte des Eisenbahnwesens, Heft 2, 15. Januar, S. 17.
GRAMS (R.). — Allgemeine Untersuchung des **gefederten Oberbaues auf Brücken.** (4 800 Wörter & Abb.)

1943 **625 .232 (.43)**
Organ für die Fortschritte des Eisenbahnwesens, Heft 2, 15. Januar, S. 24.
KOBSCHÜTZKY (Hans). — Entwurf von **Doppelstock-Vierwagen-Einheiten** mit grossem Fassungsvermögen für D- und Eilzüge. (3 600 Wörter, Tafeln & Abb.)

1943 **62 (01. & 625 .23**
Organ für die Fortschritte des Eisenbahnwesens, Heft 3, 1. Februar, S. 34.
ERDÖS (A.). — Einige Formeln zur **Festigkeitsberechnung von Wagenkästen.** (3 600 Wörter & Abb.)

1943 **621 .138 (01**
Organ für die Fortschritte des Eisenbahnwesens, Heft 4, 15. Februar, S. 49.
ECKHARDT (F.). — Über den **Wärmeübergang** im Stephensonkessel. (3 000 Wörter & Abb.)

1943 **385 (09 (.56 + .62)**
Organ für die Fortschritte des Eisenbahnwesens, Heft 4, 15. Februar, S. 53.
WERNEKKE. — Die **Eisenbahnen Ägyptens** und seiner Nachbarländer. (7 000 Wörter & Karten.)

1943 **625 .258 & 656 .212 .5**
Organ für die Fortschritte des Eisenbahnwesens, Heft 5, 1. März, S. 65.
POTTHOFF (Gerhart). — Die Betriebsuntersuchung von **Abrollanlagen.** (3 500 Wörter, 5 Tabellen & Abb.)

1943 **385**
Organ für die Fortschritte des Eisenbahnwesens, Heft 5, 1. März, S. 71.
WIENS. — Die **Zukunft des Schienenweges** (Vortrag gehalten am 22.1.1943 in der Studiengemeinschaft der japanischen Ingenieure in Deutschland). (5 500 Wörter.)

Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)

1943 **621 .43**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 1/2, 9. Januar, S. 7; Nr. 13/14, 3. April, S. 177.
ZEMAN (J.). — Die neuere Entwicklung des **Zweitaktmotors.** I. Verfahren und Einrichtungen für den Ladungswechsel. — II. Konstruktive Gestaltung. — III. Arbeitsverfahren. (8 000 Wörter & Abb.)

1943 **621 .7, 621 .9 & 669**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 1/2, 9. Januar, S. 15.
SCHALBROCH (H.) & LANG (M.). — **Messung der Schnittemperatur** mittels temperaturanzeigender Farbanstriche. (5 500 Wörter & Abb.)

1943 **669 .1**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 1/2, 9. Januar, S. 25.
Die mechanischen Eigenschaften **molybdänfreier Einsatz- und Vergütungsstähle.** (700 Wörter, Tafeln & Abb.)

1943 **656 .212 .6 (.485)**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 5/6, 6. Februar, S. 79.
IDEL (Karl). — **Verladebrücke** mit verschieb- und schwenkbarem Brückenträger (durch Demag, Duisburg) in einem schwedischen Hafen aufgestellt. (1 250 Wörter & Abb.)

1943 **621 .134 .1**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 7/8, 20. Februar, S. 89.
ROOSEN (Richard). — Der **Einzelachsantrieb bei Dampflokomotiven.** (12 000 Wörter, Tafeln & Abb.)

1943 **621 .82 & 669**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 7/8, 20. Februar, S. 105.
BRENNER (P.). — Kupferfreie **Aluminiumlegierungen** hoher Festigkeit. (4 500 Wörter & Abb.)

1943 **62 (01 & 669 .1**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 9/10, 6. März, S. 123.
FRY (A.) & KIRSCHFELD (L.). — Über die **Alterungsempfindlichkeit von Baustählen** hoher Festigkeit. (3 900 Wörter, 2 Tafeln & Abb.)

1943 **627 .82 & 721 .1**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 9/10, 6. März, S. 129.
WINTER (R. H.). — Arbeiten zur **Untergrundfestigung** an einer grossen Talsperre. (2 300 Wörter & Abb.)

1943 **621 .82 (.43) & 621 .9 (.43)**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 11/12, 20. März, S. 155.
ZWICH (Kurt). — Versuche mit **Spindelmuttern aus Zinklegierungen** für Werkzeugmaschinen. (2 500 Wörter, 1 Tafel & Abb.)

1943 **624 .6**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 23/24, 12. Juni, S. 354.
CRAEMER (H.). — Die tragende Mitwirkung des Aufbaus bei massiven **Bogenbrücken.** (800 Wörter.)

1943 **721 .9**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 23/24, 12. Juni, S. 368.
Verhinderung von Temperaturschäden in grossen **Betonbauten.** (1 000 Wörter & Abb.)

1943 **625 .2 (01 & 669**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 25/26, 26. Juni, S. 377.
CLEFF (Th.). — **Leichtbaugestaltung** im Grossfahrzeugbau. (6 000 Wörter, 2 Zahlentafeln & Abb.)

1943 **62. (01**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 25/26, 26. Juni, S. 399.
BERTHOLD (R.). — **Prüfstand für Magnetpulver.** (2 000 Wörter, 1 Zahlentafel & Abb.)

1943 **621 .82**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 27/28, 10. Juli, S. 409.
KLEMENCIE (A.). — Bemessung und Gestaltung von **Gleitlagern.** (6 500 Wörter & Abb.)

1943 **62. (01, 621 .392 & 669 .1**
Zeitschrift des Vereines deutscher Ingenieure, Nr. 27/28, 10. Juli, S. 422.
GRAFF (O.). — Beurteilung der **Eigenschaften hochfester Baustähle für geschweisste Tragwerke.** (1 600 Wörter, 2 Zahlentafeln & Abb.)

In English.

Engineer. (London.)

1946 **625 .245 (.**
Engineer, No. 4 740, November 15, p. 452.
L. M. S. **wagon for roadstone transport.** (400 wor

1946 **621 .132 .8 (.**
Engineer, No. 4 741, November 22, p. 458.
POULTNEY (E. C.). — **Modern locomotive practi**
Pennsylvania Railway. (3 500 words & fig.)

1946 **621 .33 (.4**
Engineer, No. 4 741, November 22, p. 467.
Electrification of the Spanish State Railways. (1
words & map.)

1946 **621 .132 .8 (.42) & 621 .438 (.4**
Engineer, No. 4.742, November 29, p. 489.
2 500 H. P. Gas turbine-electric locomotive (800 wo
& fig.)

Engineering. (London.)

1946 **625 .13 (.**
Engineering, No. 4 218, November 15, p. 457.
Raising **railway bridge** over Tennessee river. (2
words & fig.)

1946 **621 .131 .8 (.73) & 621 .438 (.**
Engineering, No. 4 218, November 15, p. 462.
Coal-burning **gas-turbine locomotive.** (400 words.)

1946 **621**
Engineering, No. 4 218, November 15, p. 475; No. 4 2
November 22, p. 500; No. 4 220, November
p. 524.
The **development of the fluorescent lamp.** (7 800 wor
fig. & diagrams.)

1946 **621 .4**
Engineering, No. 4 220, November 29, p. 512.
Liner-wear and crankshaft alignment indicator. (6
words & fig.)

1946 **621 .132 .8 (.42) & 621 .438 (.4**
Engineering, No. 4 220, November 29, p. 523.
Gas-turbine locomotive for Great Western Railw
(700 words.)

Great Western Railway Magazine. (London.

1946 **625 .144 .4 (.**
Great Western Railway Magazine, No. 11, Novemb
p. 243.
Flat bottom rails. An interesting **new method of driv**
the elastic spikes. (300 words & fig.)

Journal, Institution of Civil Engineers. (London.)

1946 **62. (01**

Journal, Institution of Civil Engineers, No. 1, November, p. 85.

HENDRY (A. W.). — **Photo-elastic apparatus,** technique and materials. (2 200 words & fig.)

The Locomotive. (London.)

1946 **621 .132 .6 (.42)**

The Locomotive, No. 651, November 15, p. 162.

New 2-4-6 Tanks for the Northern Counties Committee (L. M. S.) (700 words & fig.)

1946 **621 .138 .3**

The Locomotive, No. 651, November 15, p. 163.

Some effects of design on the **maintenance and servicing of engines.** (1 500 words.)

1946 **621 .132 .8**

The Locomotive, No. 651, November 15, p. 167.

JOUANNO (A. G.). — Proposed constant adhesion **articulated locomotive.** (1 400 words & fig.)

Mechanical Engineering. (New York.)

1946 **691**

Mechanical Engineering, November, p. 943.

SMITH Jr. (H. E.). — **Corrosion** is no accident. (3 000 words & fig.)

1946 **621 .431 .7**

Mechanical Engineering, November, p. 953.

LEWIS (C. B.) & EDWARDS (M. A.). — Electro-hydraulic control of **Diesel-electric drives.** (2 000 words & fig.)

1946 **621 .431 .72**

Mechanical Engineering, November, p. 987.

6 000 H. P. Diesel-electric locomotive. (1 100 words & fig.)

Modern Transport. (London.)

1946 **625 .232 (.94)**

Modern Transport, August 10, p. 6.

A **sleeping-car** experiment in Australia. (900 words & fig.)

1946 **625 .242 (.42)**

Modern Transport, August 10, p. 14.

BAILEY (D.). — Railway **wagons for mineral traffic.** Limitations on carrying capacity. (1 600 words.)

1946 **621 .138 .1 (.42)**

Modern Transport, August 10, p. 15.

Modernisation of running sheds. L. M. S. depot at Carnforth. (700 words & fig.)

1946 **621 .133 .1 (.42)**

Modern Transport, August 17, p. 5.

Oil fuel for steam locomotives. Extension of G. W. R. experiments. (1 800 words & fig.)

1946 **656 .211 .5 (.42)**

Modern Transport, August 17, p. 17.

Indication signs in vitreous enamel. A new type for Southern Railway stations. (240 words & fig.)

1946 **625 .232 (.42)**

Modern Transport, August 24, p. 3; August 31, p. 4.

New **rolling-stock for L. M. S. Royal Train.** (4 500 words & fig.)

1946 **656 .283 (.42)**

Modern Transport, August 24, p. 17.

Three trains in **collision.** Report on Potters Bar Accident. (2 000 words.)

1946 **385. (09 (.54)**

Modern Transport, September 7, p. 15.

Railways in India. Progress under State Control. (2 000 words.)

1946 **625 .13 (.42)**

Modern Transport, September 7, p. 20.

An interesting G. W. R. **bridge renewal.** (450 words & fig.)

1946 **625 .232 (.42)**

Modern Transport, September 7, p. 20.

New Southern **suburban trains.** Communicating compartments. (400 words & fig.)

1946 **385. (09 (.485)**

Modern Transport, September 14, p. 9.

Modernizing a Swedish private railway. Metamorphosis of the Bergslagen. (1 300 words & fig.)

1946 **621 .13**

Modern Transport, September 21, p. 11.

POULTNEY (E. C.). — A study in **locomotive evolution.** From Ramsbottom to Stanier. (950 words & fig.)

The Oil Engine. (London.)

1946 **621 .132 .8 (.42) & 621 .438 (.42)**

The Oil Engine, No. 163, November, p. 223.

A **dual-fuel engined locomotive.** A pioneer machine which operates at about 55 % of the cost of a steam locomotive. (900 words & fig.)

1946 **621 .132 .8 (.494) & 621 .438 (.494)**

The Oil Engine, No. 163, November, p. 225.

Gas-turbine locomotive experience. Latest information concerning the pioneer unit. (600 words & fig.)

Proceedings, American Society of Civil Engineers. (New York.)

1940 **721 .9**

Proc., Americ. Soc. Civil Eng., No. 4, April, Part 1, p. 589.

ERNST (G. C.). — Design of **hinges and articulations in reinforced concrete structures.** (5 000 words & fig.)

1940 **691 & 721 .9**

Proc., Americ. Soc. Civil Eng., No. 10, December, p. 1749.

WHITNEY (Ch. S.). — Plastic theory of **reinforced concrete design.** (7 000 words, tables & fig.)

1940 **62. (01 & 691**

Proc., Americ. Soc. Civil Eng., No. 10, December, p. 1781.

STANTON (Th. E.). — **Expansion of concrete** through reaction between cement and aggregate. (8 000 words, tables & fig.)

1941 **624 .2**

Proc., Americ. Soc. Civil Eng., No. 1, January, p. 3.

VOODHIGULA (O T.). — **Analysis of statically indeterminate trussed structures** by successive approximations. (1 500 words, tables & fig.)

1941 **721 .1 (.73)**

Proc., Americ. Soc. Civil Eng., No. 1, January, p. 15.

BURMISTER (D. M.). — **Laboratory investigations of soils** at Flushing Meadow Park. (3 500 words & fig.)

1941 **62. (01 & 691**

Proc., Americ. Soc. Civil Eng., No. 1, January, p. 33.

HADLEY (H. M.). — **Concrete in sea water :** a revised viewpoint needed. (4 000 words & fig.)

1941 **624 .2**

Proc., Americ. Soc. Civil Eng., No. 1, January, p. 47.

BERNHARD (R. K.). — **Dynamic stress analysis of railway bridges.** (3 000 words & fig.)

1941 **624 .2**

Proc., Americ. Soc. Civil Eng., No. 1, January, p. 93.

BAES (L.). — **Rigid frames without diagonals.** (The Vierendeel truss.) (3 500 words & fig.)

1941 **624 .51**

Proc., Americ. Soc. Civil Eng., No. 2, February, p. 177.

GRONQUIST (C. H.). — Simplified theory of the self-anchored **suspension bridge.** (5 000 words, tables & fig.)

1941 **624 .2**

Proc., Americ. Soc. Civil Eng., No. 2, February, p. 199.

WESTERGAARD (H. M.). — On the **method of complementary energy** and its application to structures stressed beyond the proportional limit, to buckling and vibrations, and to suspension bridges. (9 000 words, tables & fig.)

1941 **624**

Proc., American Soc. Civil Eng., No. 3, March, p. 405

JOHNSTON (B.) & MOUNT (Ed. H.). — Analy of **building frames with semi-rigid connections.** (6 words, tables & fig.)

1941 **624**

Proc., Americ. Soc. Civil Eng., No. 4, April, Part p. 517.

BIRDSALL (B.). — The **suspension bridge to cantilever problem.** (4 000 words & fig.)

1941 **625 .13 (.7**

Proc., Americ. Soc. Civil Eng., No. 4, April, Part p. 617.

FELD (J.). — **Tunnel construction,** Sixth Avenue s way, New York, N. Y. (8 000 words & fig.)

1941 **624 .2 (.7**

Proc., Americ. Soc. Civil Eng., No. 5, May, p. 781.

SMITH (L. T.) & LILLARD (P.). — **Extensome stress measurements,** North Avenue Bridge, Chicago, (5 500 words & fig.)

Railway Age. (New York.)

1946 **621 .431 .72 (.73) & 656 .22 (.7**

Railway Age, September 7, p. 397.

Rolling through Michigan. (6 000 words & fig.)

1946 **621 .135 .2 (.73) & 625 .212 (.7**

Railway Age, September 7, p. 406.

Bethlehem Steel modernizes its **axle manufacturi facilities.** (600 words & fig.)

1946 **625 .144 .4 (.7**

Railway Age, September 13, p. 432.

This new **ballast cleaner** is different (2 100 words fig.)

1946 **656 .254 (.7**

Railway Age, September 13, p. 443.

ZANE (W. F.). — **C. T. C.** on a 131-mile subdivisic (2 000 words & fig.)

1946 **625 .23 (.7**

Railway Age, September 21, p. 470.

DOULTON STOTT (R.). — One aspect of **coach m dernization** (700 words & fig.)

1946 **656 .254 (.7**

Railway Age, September 21, p. 479.

N. P. tests **radio train communication.** (1 800 words fig.)

1946 **625 .144 .4 (.7**

Railway Age, September 28, p. 515.

Roadmasters tackle problems with vigor in ann meeting at Chicago. (7 000 words.)

946 **656 .254 (.73)**
way Age, September 28, p. 523.
Darlington shows two-way **yard radio.** (600 words &

---

946 **625 .236 (.73)**
way Age, September 28, p. 537.
The B. & M.'s new « **car laundry** ». (70 words & fig.)

Railway Engineering and Maintenance. (Chicago.)

944 **625 .144 (.73)**
way Engineering and Maintenance, May, p. 438.
ersey Central lays 78-ft. rails in two-miles **test track.** 00 words & fig.)

1944 **625 .144 .1 (.73) & 665 .882 (.73)**
ilway Engineering and Maintenance, June, p. 522.
AMPBELL (F. G.). — E. J. E. E. lays 5 1/2 miles **welded rail.** (2 800 words & fig.)

1944 **625 .144 .1 (.73) & 665. 882 (.73)**
lway Engineering and Maintenance, July, p. 608.
ric **welds Otisville tunnel rails in track** by Thermit -fusion process. (3 500 words & fig.)

1944 **621 .392 (.73); 625 .143 (.73) & 665 .882 (.73)**
lway Engineering and Maintenance, August, p. 698.
DALEY (C. A.). — Wartime problems emphasize **role welding in maintenance work.** (3 000 words & fig.)

1944 **625 .144 (.73)**
ilway Engineering and Maintenance, August, p. 706.
N. E. W. adopts giant **tie plate** for use at severe lo- ions. (2 400 words & fig.)

1944 **625 .143 .3 (.73)**
ilway Engineering and Maintenance, Decemb., p. 1134.
Maul blows on webs **crack rails** at low temperatures. 500 words & fig.)

1944 **625 .174 (.73)**
ilway Engineering and Maintenance, Decemb., p. 1137.
SUGHRUE (T. G.) & RICHARDSON (L.). — **Snow elter** proves worth at this large station. (1 500 words fig.)

Railway Gazette. (London.)

1946 **625 .143 .1 (.42)**
ilway Gazette, No. 7, August 16, p. 178.
Flat-bottom track in Great Britain. (750 words & fig.)

1946 **621 .335 (.494)**
Railway Gazette, No. 7, August 16, p. 180.
New **electric locomotives** for Lötschberg railway. (2 300 words & fig.)

1946 **625 .13 (.944)**
Railway Gazette, No. 7, August 16, p. 187.
The new Hawkesbury **river bridge.** (1 000 words & fig.)

1946 **621 .133 .1 (.42)**
Railway Gazette, No. 7, August 16, p. 194.
More **oil-burning locomotives** are to be used on the G. W. R. (200 words & fig.)

1946 **385 .517 .7 (.42)**
Railway Gazette, No. 8, August 23, p. 203.
G. W. R. **housing scheme** difficulties. (850 words.)

1946 **388 (.489)**
Railway Gazette, No. 8, August 23, p. 210.
Railway planning in Copenhagen. (900 words & fig.)

1946 **621 .95 (.42)**
Railway Gazette, No. 8, August 23, p. 212.
Auto-pneumatic indexing **drilling jig.** (450 words & fig.)

1946 **621 .132 .8**
Railway Gazette, No. 8, August 23, p. 213.
The Henschel **condensing locomotive.** (1 200 words & fig.)

1946 **656 .253 (.42)**
Railway Gazette, No. 8, August 23, p. 214.
Northallerton to Darlington **resignalling,** L. N.E. R. (2 400 words & fig.)

1946 **385. (09 (.47)**
Railway Gazette, No. 8, August 23, p. 224.
KOVALEV (J.). — Development of Soviet **railway transport.** (1 200 words.)

1946 **656 .283 (.42)**
Railway Gazette, No. 9, August 30, p. 250.
Ministry of Transport **Accident Report.** Potters Bar, L. N. E. R. : February 10, 1946. (3 800 words & plan.)

1946 **621 .132 .1 (.73)**
Railway Gazette, No. 10, September 6, p. 266.
POULTNEY (E. C.). — **Modern American locomotives.** The comparison of powers and design features of a number of leading types. (3 500 words, table & fig.)

1946 **385 (.07 (.42)**
Railway Gazette, No. 10, September 6, p. 272.
Training centre for L. N. E. R. clerical staff. (1 400 words & fig.)

1946 **656 .212 .6 (.42)**
Railway Gazette, No. 10, September 6, p. 277.
Douglas **high-lift truck and stillage system.** (750 words & fig.)

Railway Mechanical Engineer. (New York.)

1946 **621 .132 (.73)**
Railway Mechanical Engineer, May, p. 239.
KERR (Charles, Jr.). — A look at **locomotives of tomorrow.** (5 000 words & fig.)

1946 **621 .13 (.73)**
Railway Mechanical Engineer, May, p. 249.
A. R. E. A. reports on **locomotive economics.** (6 400 words.)

1946 **621 .392 (.73) & 625 .245 (.73)**
Railway Mechanical Engineer, May, p. 254.
All-welded cor-ten hopper. (900 words & fig.)

1946 **625 .23 (.73)**
Railway Mechanical Engineer, May, p. 260.
Terminal conditioning **passenger cars.** (4 700 words.)

1946 **625 .245 (.73)**
Railway Mechanical Engineer, May, p. 263.
Hopper-car program at Mc Comb shops (600 words & fig.)

1946 **621 .138 .5 (.73)**
Railway Mechanical Engineer, May, p. 271.
Light and power for the **Diesel locomotive shop.** (1 900 words & fig.)

1946 **625 .233**
Railway Mechanical Engineer, May, p. 276.
Is **15 foot candles the upper limit** for passenger cars? (1 800 words & fig.)

1946 **656 .254 (.73)**
Railway Mechanical Engineer, May, p. 278.
Seaboard tests **train radio warning signals.** (750 words & fig.)

1946 **621 .431 .72 (.73)**
Railway Mechanical Engineer, June, p. 289.
Ingolls builds first **Diesel locomotive.** (2 000 words & fig.)

1946 **625 .24 (0**
Railway Mechanical Engineer, June, p. 292.
STUEBING (A. F.). — A **corrective for high tare.** (3 600 words & fig.)

1946 **621 .132 .5 (.73)**
Railway Mechanical Engineer, June, p. 295.
Chicago & North Western **4-8-4 locomotives modernized.** (2 500 words & fig.)

1946 **614 .8, 621 .431 .72 & 693**
Railway Mechanical Engineer, June, p. 299.
Causes and remedies of fires in Diesel locomotives. (2 700 words.)

1946 **625 .212**
Railway Mechanical Engineer, June, p. 310; July, p. 354.
BARTHELEMY (P. P.). — Handling **freight-car wheel changes.** (3 500 words & fig.)

University of Illinois Bulletin. (Urbana.)

1943 **625 .143 .3**
University of Illinois Bulletin, No. 33, April 6.
ALLEMAN (N. J.), CRAMER (R. E.) & JEN (R. S.). — Ninth progress report of the joint in gation of **fissures in railroad rails.** (16 pp. Illustra

---

1943 **625 .143 .3**
University of Illinois Bulletin, No. 34, April 13.
CRAMER (R. E.). — First progress report of **investigation of shelly spots in railroad rails.** (12 Illustrated.)

1943 **625 .143 .4**
University of Illinois Bulletin, No. 35, April 20.
ALLEMAN (N. J.). — First progress report of investigation of **fatigue failures in rail joint bars.** (1 Illustrated.)

1943 **6**
University of Illinois Bulletin, No. 38, May 11.
RICHART (F. E.) & WILLIAMS (C. B., Jr.) Tests of composite **timber and concrete beams.** (62 Illustrated.)

1943 **624 .2 &**
University of Illinois Bulletin, No. 40, June 22.
JENSEN (V. P.). — Ultimate strength of **reinf concrete beams** as related to the plasticity rati concrete. (62 pp. Illustrated.)

1943 **691 &**
University of Illinois Bulletin, No. 45, June 29.
DRAFFIN (J. O.). — A brief history of **lime, cer concrete and reinforced concrete.** (48 pp.)

1943 **624**
University of Illinois Bulletin, No. 46, July 6.
JENSEN (V. P.), KLUGE (R. W.) & WILLI (C. B., Jr.). — **Highway slab-bridges with cu** Laboratory tests and proposed design method. (88 tables & fig.)

In Spanish.

Boletin de la Asociacion Internacional Permanente del Congreso Panamericano de Ferrocarriles. (Buenos-Aires.)

1946 **385. (09**
Boletin de la Asoc. intern. perm. del Congreso americ. de Ferrocarriles, septiembre-octubre, p.
MARTINS COSTA (P.). — El **transporte ferrov** en el Brasil al termino del conflicto mundial y la a sicion del material de traccion diesel-electrico. (palabras.)

1946 **625 .144 .1 (.460) & 665 .882 (.**
Boletin de la Asoc. intern. perm. del Congreso americ. de Ferrocarriles, septiembre-octubre, p.
MONEVA (F.). — La **soldadura aluminotermic carriles en las lineas ferreas.** (3 500 palabras.)

Ferrocarriles y Tranvias. (Madrid.)

944 **625 .2 (01**
rocarriles y Tranvias, febrero, p. 50.
OICOECHEA (A.). — El **aligeramiento** en el trans-e ferroviario. (6 000 palabras & fig.)

944 **625 .143 .3**
rocarriles y Tranvias, febrero, p. 63.
ASADO (T. F.). — Un nuevo **defecto de fatiga** en carriles. (1 200 palabras.)

944 **656 (.42)**
rocariles y Tranvias, febrero, p. 78.
ropuesta sobre **el transporte de la postguerra** en In-erra. (Communication de B. D. Richards à l'Insti-on of Civil Engineers, d'après la « Railway Gazette » 26 novembre 1943.) (2 000 palabras.)

944 **385 .524 (.460)**
rocarriles y Tranvias, marzo, p. 96.
UTIERREZ SEGURA (J. F.). — **Primas a la pro-ción** en los talleres generales de la RENFE. (2 000 abras.)

944 **385. (09 (.460)**
rocarriles y Tranvias, marzo, p. 103.
'OBALINA (E.). — **Ferrocarriles** navarros. (1 500 abras & fig.)

944 **625 .42 (.460)**
rocarriles y Tranvias, marzo, p. 110.
ABRERA (J. B.). — La nueva línea del « **Metro** » Madrid. (1 500 palabras & fig.)

944 **624 .2**
rocarriles y Tranvias, abril, p. 142.
MENDIZABAL (D.). — Esfuerzos y deformaciones de gen térmico en los **tramos metálicos** de vigas rectas. 500 palabras & fig.)

944 **625 .13 (.460)**
rrocarriles y Tranvias, abril, p. 154.
ABRERA (F.). — **Reparación del túnel** de San zaro, en la línea de Oviedo a la de Ujo a Trubia, de « Vasco Asturiana ». (800 palabras & fig.)

944 **621 .33 (.460)**
rrocarriles y Tranvias, mayo, p. 189.
FERNANDEZ CANO (A. H.). — La **electrificación** de eas férreas. (1 500 palabras & fig.)

944 **621 .33 (.460)**
rrocarriles y Tranvias, mayo, p. 192.
BUENO (P. G.). — **Electrificación** de transportes ter-stres. (12 000 palabras.)

944 **621 .31 (.460)**
rrocarriles y Tranvias, mayo, p. 205.
GRASSET JAMAR (J. L.). — La **producción de ergía** y las electrificaciones ferroviarias. (8 000 palabras fig.)

944 **621 .33 (.460)**
Ferrocarriles y Tranvias, mayo, p. 218.
VIANI (M.). — La **electrificación** de Madrid a Avila y Segovia. (11 000 palabras & fig.)

944 **621 .335 (.460) & 621 .338 (.460)**
Ferrocarriles y Tranvias, mayo, p. 236.
DEL CASTILLO (A.). — **Locomotoras y unidades de tren.** (10 000 palabras & fig.)

944 **621 .331 (.460)**
Ferrocarriles y Tranvias, mayo, p. 259.
TAPIA (F. J.). — **Subestaciones** convertidoras de energía. (4 000 palabras & fig.)

944 **621 .332 (.460)**
Ferrocarriles y Tranvias, mayo, p. 270.
ANGULO ALVAREZ (A.). — La **linea de contacto.** (2 000 palabras & fig.)

944 **656 .256 .3 (.460)**
Ferrocarriles y Tranvias, mayo, p. 274.
LAZARO (M.). — Las **instalaciones de seguridad.** (2 000 palabras & fig.)

944 **621 .33 (.460) & 654 (.460)**
Ferrocarriles y Tranvias, mayo, p. 278.
ESPINO Y ESPINO (F.). — La **comunicaciones telefónicas.** (4 000 palabras & fig.)

944 **621 .33**
Ferrocarriles y Tranvias, mayo, p. 289.
HUG (Ad. M.). — Cuestiones económicas de la **tracción eléctrica** en explotación. (3 500 palabras.)

Revista de Obras Públicas. (Madrid.)

1946 **62. (01 & 691**
Revista de Obras Públicas, noviembre, p. 502.
SANTOLARIA (E.). — Un cuento... de verdad sobre **compacidad de hormigones.** (1 800 palabras, 3 cuadros & fig.)

In Italian.

Giornale del Genio Civile (Roma).

1946 **624 .6**
Giornale del Genio Civile, luglio-agosto, p. 354.
GHERARDELLI (L.). — Criteri idraulici nell' **architettura dei ponti a più luci.** (2 000 parole & fig.)

L'Ingegnere. (Milano.)

1946 **624 .2 & 721 .9**
L'Ingegnere, settembre, p. 713.
PEDOTTI (M.). — Nuovi **metodi di calcolo per le travi inflesse in cemento armato :** il metodo Gebauer. (5 000 parole & fig.)

Rivista tecnica delle Ferrovie italiane. (Roma.)

1943 **625 .245 (.45)**

Rivista tecnica delle ferrovie italiane, 15 gennaio, p. 1.
DEL GUERRA (G.). — **Carri-serbatoio** di tipo alleggerito per trasporto di carburanti. (2 400 parole & fig.)

1943 **621 .392 (.45)**

Rivista tecnica delle ferrovie italiane, 15 gennaio, p. 6.
PROSPERI (L.) & DE ROSA (G.). — La **saldaturo elettrica** e la sua applicazione nella costruzione delle **carpenterie metalliche leggere** ed in particolare dei **pali a traliccio.** (9 000 parole & fig.)

1943 **533, 625 .23 & 656 .221**

Rivista tecnica delle ferrovie italiane, 15 gennaio, p. 21.
LATTANZI (B.). — Metodi, attrezzature ed **risultati aerodinamici di prove su modelli dei veicoli terrestri.** (8 000 parole & fig.)

1943 **625 .111 & 625 .144 .2**

Rivista tecnica delle ferrovie italiane, 15 marzo, p. 69.
GIORGI (G. de). — Communicazioni fra **binari paralleli in curva circolare.** (2 500 parole & fig.)

1943 **656 .256 & 656 .258**

Rivista tecnica delle ferrovie italiane, 15 marzo, p. 74.
GUZZANTI (C.). — L'impego dei **circuiti di binario** negli impianti di apparati centrali. (13 000 parole, tavole & fig.)

1943 **625 .214**

Rivista tecnica delle ferrovie italiane, 15 aprile, p. 97.
MARIANI (R.). — Un **nuovo tipo di cuscinetti** per veicoli ferroviari. (1 000 parole & fig.)

1943 **625 .244 (.45) & 656 .225 (.45)**

Rivista tecnica delle ferrovie italiane, 15 aprile, p. 100.
MASCINI (A.). — Il **trasporto di derrate alimentari congelate** a bassa temperatura. (15 000 parole & fig.)

1943 **624 .32 (.45)**

Rivista tecnica delle ferrovie italiane, 15 maggio, p. 129.
POLSONI (G.). — Costruzione di stilate pendolari per il **ripristino di un viadotto metallico.** (2 400 parole, tavole & fig.)

1943 **621 .335**

Rivista tecnica delle ferrovie italiane, 15 maggio, p. 138.
MARTINELLI (M.). — **Esperimento di locomotiva elettrica** a corrente continua a 3 000 V. munita di motori con eccitazione composta eseguito dalle Ferrovie dello Stato. (5 500 parole & fig.)

1943 **625 .172 (.45)**

Rivista tecnica delle ferrovie italiane, 15 giugno, p. 165.
LIDONNICI (A.). — L'apparechio Pollak-Charvat registratore dello scartamento e della sopraelevazione del binario. (3 000 parole & fig.)

1943 **656**

Rivista tecnica delle ferrovie italiane, 15 giugno, p. 15 luglio, p. 214.
MASCINI (A.). — La sicurezza nel trasporto dei pienti contenenti gas compressi, liquefatti e disciolti pressione. (12 000 parole, tavole & fig.)

1943 **656 .2**

Rivista tecnica delle ferrovie italiane, 15 luglio, p.
STAGNI (E.). — Un criterio per la scelta delle convenienti composizioni di treno in caso di tr intensi. (7 000 parole, tabelle & fig.)

1943 **625 .25 & 62**

Rivista tecnica delle ferrovie italiane, 15 agosto, p.
FASOLI (M.). — Una semplificazione ed un perf namento nell' apparecchiatura del freno degli el treni. (2 000 parole & fig.)

In Dutch.

Spoor- en Tramwegen. (Utrecht.)

1944 **385 .1 (.**

Spoor- en Tramwegen, Nr 4, 12 Februari, p. 44.
De **saneering** der Zwitsersche Bondsspoorwegen. (woorden & fig.)

1944 **621 .13**

Spoor- en Tramwegen, Nr 4, 12 Februari, p. 47.
DERENS (L.). — **2 B 1 « Atlantic » sneltrein loc tieven.** (1 200 woorden & 1 tabel.)

1944 **621 .33 (.**

Spoor- en Tramwegen, Nr 5, 26 Februari, p. 53.
VAN LESSEN (H. J.). — De **electrische tract** Zwitserland. (3 000 woorden, tabellen & fig.)

1944 **385. (09 (.**

Spoor- en Tramwegen, Nr 5, 26 Februari, p. 60; N 11 Maart, p. 71; Nr 7, 25 Maart, p. 85.
FRANCKEN (A. D.). — **Uit het heden en het v den** van den « New-York Central Railroad ». (woorden & fig.)

1944 **625**

Spoor- en Tramwegen, Nr 6, 11 Maart, p. 73; N 8 April, p. 99.
Het « **slippen** » van treindeelen. (1 800 woorden &

1944 **625 .232 (.492) & 625 .234 (.**

Spoor- en Tramwegen, Nr 7, 25 Maart, p. 77.
VAN ELDIK THIEME (H. C. A.). — De inrich voor **luchtbehandeling** van het Bioscooprijtuig. (1 woorden & fig.)

1944 **656 .225 (09 & 656 .261**

Spoor- en Tramwegen, Nr 8, 8 April, p. 89.
REITSMA (S. A.). — Van oude wijn en nieuwe ken. (A propos des containers et de leur histo (1 800 woorden & fig.)

1944 **625 .172 (.493)**

oor- en Tramwegen, Nr 9, 22 April, p. 103.

LUYTEN (E. F. P.). — **Instandhouding van de nivel-ering van het spoor** door de methode der gemeten op-oging. (5 000 woorden & fig.)

1944 **656 .251**

oor- en Tramwegen, Nr 10, 6 Mei, p. 115.

VERSTEGEN (J. H.). — Over **meervoudige seinbeel-n.** (Multiple aspect signals.) (1 500 woorden & fig.)

1944 **625 .112**

oor- en Tramwegen, Nr 11, 20 Mei, p. 127; Nr 12, 3 Juni, p. 143; Nr 13, 17 Juni, p. 151; Nr 14, 1 Juli, p. 167; Nr 15, 15 Juli, p. 178; Nr 16, 29 Juli, p. 193; Nr 17, 12 Augustus, p. 201; Nr. 18, 18 Augustus, p. 217.

REITSMA (S. A.). — Een en ander over **spoorwijdten,** eer in het bijzonder over de toepassing van « smalle » oorwijdten in Nederlandsch-Indië. (2 600 woorden & g.)

1944 **656 .225 (.492) & 656 .261 (.492)**

oor- en Tramwegen, Nr 11, 20 Mei, p. 135.

HELLINGS (J. B.). — Het vervoer in **spoorweg-adkisten.** (1 000 woorden.)

1944 **656 .253 (.43) & 656 .256 .3 (.43)**

Spoor- en Tramwegen, Nr 12, 3 Juni, p. 139.

LAPONDER (A. J.). — De **daglichtseinen** van de « Stadtbahn ». (3 000 woorden & fig.)

1944 **625 .231 (.492)**

Spoor- en Tramwegen, Nr 13, 17 Juni, p. 155.

KARSKENS (J. J.). — Een merkwaardige **verbou-wing van rijtuigen** 1ste en 2de klasse. (1 600 woorden & fig.)

1944 **385. (09 (.61)**

Spoor- en Tramwegen, Nr 13, 17 Juni, p. 158.

De **spoorwegen** van Tripolitanië. (600 woorden & kaart.)

In Portuguese.

Gazeta dos Caminhos de ferro. (Lisboa.)

1946 **385. (09 (.44)**

Gazeta dos Caminhos de ferro, nº 1414, 16 de Novembro, p. 717.

GUERRA MAIO. — **Os progressos** dos Caminhos de Ferro Franceses. (1 000 palavras.)

M. Weissenbruch & Co., Ltd., Printer to the King, 49, rue du Poinçon, Bruxelles.